

25 TEXAS ADMINISTRATIVE CODE

§289.257

Packaging and Transportation of Radioactive Material

Texas Regulations for Control of Radiation

(effective March 1, 1998)

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(March 2000)

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### §289.257 Packaging and Transportation of Radioactive Material.

#### (a) Purpose.

(1) This section establishes requirements for packaging, preparation for shipment, and transportation of radioactive material including radioactive waste.

(2) The packaging and transport of radioactive material are also subject to the requirements of §289.201 of this title (relating to General Provisions), §289.202 of this title (relating to Standards for Protection Against Radiation), **§289.203 of this title (relating to Notices, Instructions, and Reports to Workers; Inspections)**, §289.204 of this title (relating to Fees for Certificates of Registration, Radioactive Material(s) Licenses, Emergency Planning and Implementation, and Other Regulatory Services), **§289.205 of this title (relating to Hearing and Enforcement Procedures)**, §289.251 of this title (relating to Exemptions, General Licenses, and General License Acknowledgements), §289.252 of this title (relating to Licensing of Radioactive Material), §289.254 of this title (relating to Licensing of Radioactive Waste Processing and Storage Facilities), **and §289.260 of this title (relating to Licensing of Uranium Recovery and Byproduct Material Disposal Facilities)** and to the regulations of other agencies (e.g., the United States Department of Transportation (DOT) and the United States Postal Service) having jurisdiction over means of transport. The requirements of this section are in addition to, and not in substitution for, other requirements.

#### (b) Scope.

(1) The requirements in this section apply to any licensee authorized by a specific or general license issued by the agency to receive, possess, use, or transfer radioactive material, if the licensee delivers that material to a carrier for transport, transports the material outside the site of usage as specified in the agency license, or transports that material on public highways. No provision of this section authorizes possession of radioactive material.

(2) Exemptions from the requirements for a license in subsection (c) of this section are specified in subsection (f) of this section. The general license in subsection (g) of this section requires that a United States Nuclear Regulatory Commission (NRC) certificate of compliance or other package approval be issued for the package to be used under the general license. The transport of radioactive material or delivery of radioactive material to a carrier for transport is subject to the operating controls and procedural requirements of subsections (h)-(m) of this section and to the general provisions of subsections (a)-(e) of this section, including DOT regulations referenced in subsection (e) of this section.

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(c) Requirement for license. Except as authorized in a general or specific license issued by the agency, or as exempted in this section, no licensee may transport radioactive material or deliver radioactive material to a carrier for transport.

(d) Definitions. The following words and terms when used in this section shall have the following meaning unless the context clearly indicates otherwise. To ensure compatibility with international transportation standards, all limits in this section are given in terms of dual units: The International System of Units (SI) followed or preceded by United States (U.S.) standard or customary units. The U.S. customary units are not exact equivalents, but are rounded to a convenient value, providing a functionally equivalent unit. For the purpose of this section, SI units shall be used.

(1)  $A_1$  - The maximum activity of special form radioactive material permitted in a Type A package.

(2)  $A_2$  - The maximum activity of radioactive material, other than special form, low specific activity (LSA) and surface contaminated object (SCO) material, permitted in a Type A package. These values are either listed in subsection (s)(2) of this section, or may be derived in accordance with the procedure prescribed in subsection (s)(1) of this section.

(3) BRC Forms 540, 540A, 541, 541A, 542, and 542A - Official agency forms referenced in subsection (s)(5) of this section which includes the information required by DOT in 49 Code of Federal Regulations (CFR) Part 172. BRC Form 541B contains additional information for LLRW shipments to a Texas LLRW disposal facility. Licensees need not use originals of these forms as long as any substitute forms are equivalent to the original documentation in respect to content, clarity, size, and location of information. Upon agreement between the shipper and consignee, BRC Forms 541 (and 541A and 541B) and BRC Forms 542 (and 542A) may be completed, transmitted, and stored in electronic media. The electronic media must have the capability for producing legible, accurate, and complete records in the format of the uniform manifest.

(4) Carrier - A person engaged in the transportation of passengers or property by land or water as a common, contract, or private carrier, or by civil aircraft.

(5) Certificate holder - A person who has been issued a certificate of compliance or other package approval by the agency.

(6) Chelating agent - Amine polycarboxylic acids (e.g., EDTA, DTPA), hydroxy-carboxylic acids, and polycarboxylic acids (e.g., citric acid, carboic acid, and glucinic acid).

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(7) Chemical description - A description of the principal chemical characteristics of a low-level radioactive waste (LLRW).

(8) Consignee - The designated receiver of the shipment of low-level radioactive waste.

(9) Containment system - The assembly of components of the packaging intended to retain the radioactive material during transport.

(10) Conveyance - For transport on:

(A) public highway or rail by transport vehicle or large freight container;

(B) water by vessel, or any hold, compartment, or defined deck area of a vessel including any transport vehicle on board the vessel; and

(C) aircraft.

(11) Decontamination facility - A facility operating under a NRC, agreement state, or agency license whose principal purpose is decontamination of equipment or materials to accomplish recycle, reuse, or other waste management objectives, and, for purposes of this section, is not considered to be a consignee for LLRW shipments.

(12) Disposal container - A transport container principally used to confine LLRW during disposal operations at a land disposal facility (also see definition for high integrity container). Note that for some shipments, the disposal container may be the transport package.

(13) Environmental Protection Agency (EPA) identification number - The number received by a transporter following application to the administrator of EPA as required by 40 Code of Federal Regulations (CFR) Part 263.

(14) Exclusive use - The sole use by a single consignor of a conveyance for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee. The consignor and the carrier must ensure that any loading or unloading is performed by personnel having radiological training and resources appropriate for safe handling of the consignment. The consignor must issue specific instructions, in writing, for maintenance of exclusive use shipment controls, and include them with the shipping paper information provided to the carrier by the consignor.

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(15) Fissile material - Plutonium-238, plutonium-239, plutonium-241, uranium-233, uranium-235, or any combination of these radionuclides. Unirradiated natural uranium and depleted uranium, and natural uranium or depleted uranium that has been irradiated in thermal reactors only are not included in this definition. Agency jurisdiction extends only to “special nuclear material in quantities not sufficient to form a critical mass” as defined in §289.201(b) of this title.

(16) Generator - A licensee operating under a NRC, agreement state, or agency license who:

(A) is a waste generator as defined in this section; or

(B) is the licensee to whom waste can be attributed within the context of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (e.g., waste generated as a result of decontamination or recycle activities).

(17) High integrity container (HIC) - A container commonly designed to meet the structural stability requirements of 10 CFR 61.56, and to meet DOT requirements for a Type A package.

(18) Industrial package (IP) - A packaging that, together with its low specific activity (LSA) material or surface contaminated object (SCO) contents, meets the requirements of 49 CFR 173.410 and 173.411. Industrial packages are categorized in 49 CFR 173.411 as either:

(A) Industrial package Type 1 (IP-1);

(B) Industrial package Type 2 (IP-2); or

(C) Industrial package Type 3 (IP-3).

(19) Low-level radioactive waste (LLRW) - Radioactive material that meets the following criteria:

(A) LLRW is radioactive material that is:

(i) discarded or unwanted and is not exempt by rule adopted under the Texas Radiation Control Act (Act), Health and Safety Code, §401.106;

(ii) waste, as that term is defined in 10 CFR Part 61.2; and

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(iii) subject to:

(I) concentration limits established in 10 CFR Part 61.55, or compatible rules adopted by the agency or the Texas Natural Resource Conservation Commission (TNRCC), as applicable; and

(II) disposal criteria established in 10 CFR, or established by the agency or TNRCC, as applicable.

(B) LLRW does not include:

(i) high-level radioactive waste as defined in 10 CFR Part 60.2;

(ii) spent nuclear fuel as defined in 10 CFR Part 72.3;

(iii) byproduct material defined in the Act, Health and Safety Code, §401.003(3)(B);

(iv) naturally occurring radioactive material (NORM) waste that is not oil and gas NORM waste;

(v) oil and gas NORM waste; or

(vi) transuranics greater than 100 nanocuries per gram.

(20) Low specific activity (LSA) material - Radioactive material with limited specific activity that satisfies the following descriptions and limits. Shielding materials surrounding the LSA material may not be considered in determining the estimated average specific activity of the package contents. LSA material must be in one of the following three groups:

(A) LSA-I.

(i) Ores containing only naturally occurring radionuclides (e.g., uranium, thorium) and uranium or thorium concentrates of such ores; or

(ii) Solid unirradiated natural uranium or depleted uranium or natural thorium or their solid or liquid compounds or mixtures; or

(iii) Radioactive material, other than fissile material, for which the  $A_2$  value is unlimited; or

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(iv) Mill tailings, contaminated earth, concrete, rubble, other debris, and activated material in which the radioactive material is essentially uniformly distributed, and the average specific activity does not exceed  $10^{-6} A_2$  per gram ( $A_2/g$ ).

(B) LSA-II.

(i) Water with tritium concentration up to 0.8 terabecquerel per liter (TBq/l) (20.0 curies per liter (Ci/l)); or

(ii) Material in which the radioactive material is uniformly distributed throughout, and the average specific activity does not exceed  $10^{-4} A_2/g$  for solids and gases, and  $10^{-5} A_2/g$  for liquids.

(C) LSA-III. Solids (e.g., consolidated wastes, activated materials) in which:

(i) the radioactive material is distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.); and

(ii) the radioactive material is relatively insoluble, or it is intrinsically contained in a relatively insoluble material, so that, even under loss of packaging, the loss of radioactive material per package by leaching, when placed in water for seven days, would not exceed  $0.1 A_2$ ; and

(iii) the average specific activity of the solid does not exceed  $2 \times 10^{-3} A_2/g$ .

(21) Low toxicity alpha emitters - Natural uranium, depleted uranium, natural thorium; uranium-235, uranium-238, thorium-232, thorium-228 or thorium-230 when contained in ores or physical or chemical concentrates or tailings; or alpha emitters with a half-life of less than ten days.

(22) Maximum normal operating pressure - The maximum gauge pressure that would develop in the containment system in a period of one year under the heat condition specified in 10 CFR 71.71(c)(1), in the absence of venting, external cooling by an ancillary system, or operational controls during transport.

(23) Natural thorium - Thorium with the naturally occurring distribution of thorium isotopes (essentially 100 weight percent thorium-232).

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(24) Normal form radioactive material - Radioactive material that has not been demonstrated to qualify as special form radioactive material.

(25) Package - The packaging together with its radioactive contents as presented for transport.

(A) Fissile material package - A fissile material packaging together with its fissile material contents.

(B) Type A package - A packaging that, together with its radioactive contents limited to  $A_1$  or  $A_2$  as appropriate, meets the requirements of 49 CFR 173.410 and 173.412 and is designed to retain the integrity of containment and shielding under normal conditions of transport as demonstrated by the tests set forth in 49 CFR 173.465 or 173.466, as appropriate.

(C) Type B package - A Type B packaging together with its radioactive contents. On approval by the NRC, a Type B package design is designated by NRC as B(U) unless the package has a maximum normal operating pressure of more than 700 kilopascals (kPa) (100 pounds per square inch (lb/in<sup>2</sup>)) gauge or a pressure relief device that would allow the release of radioactive material to the environment under the tests specified in 10 CFR 71.73 (hypothetical accident conditions), in which case it will receive a designation B(M). B(U) refers to the need for unilateral approval of international shipments; B(M) refers to the need for multilateral approval of international shipments. There is no distinction made in how packages with these designations may be used in domestic transportation. To determine their distinction for international transportation, see DOT regulations in 49 CFR Part 173. A Type B package approved before September 6, 1983, was designated only as Type B.

(26) Packaging - The assembly of components necessary to ensure compliance with the packaging requirements of this section. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, service equipment for filling, emptying, venting, and pressure relief, and devices for cooling or absorbing mechanical shocks. The vehicle, tie-down system, and auxiliary equipment may be designated as part of the packaging.

(27) Physical description - The items called for on BRC Form 541 to describe a LLRW.

(28) Residual waste - LLRW resulting from processing or decontamination activities that cannot be easily separated into distinct batches attributable to specific waste generators. This waste is attributable to the processor or decontamination facility, as applicable.



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(29) Shipper - The licensed entity (i.e., the waste generator, waste collector, or waste processor) who offers LLRW for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator. This definition applies only to shipments of LLRW shipped to a Texas LLRW disposal facility.

(30) Site of usage - The licensee's facility, including all buildings and structures between which radioactive material is transported and all roadways that are not within the public domain on which radioactive material can be transported.

(31) Specific activity of a radionuclide - The radioactivity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the radioactivity per unit mass of the material.

(32) Surface contaminated object (SCO) - A solid object that is not itself classed as radioactive material, but which has radioactive material distributed on any of its surfaces. A SCO must be in one of the following two groups with surface activity not exceeding the following limits:

(A) SCO-I: A solid object on which:

(i) the non-fixed contamination on the accessible surface averaged over 300 square centimeters ( $\text{cm}^2$ ) (or the area of the surface if less than  $300 \text{ cm}^2$ ) does not exceed 4 becquerels per square centimeter ( $\text{Bq}/\text{cm}^2$ ) ( $10^{-4}$  microcurie per square centimeter ( $\text{FCi}/\text{cm}^2$ )) for beta and gamma and low toxicity alpha emitters, or  $4 \times 10^{-1} \text{ Bq}/\text{cm}^2$  ( $10^{-5} \text{ FCi}/\text{cm}^2$ ) for all other alpha emitters;

(ii) the fixed contamination on the accessible surface averaged over  $300 \text{ cm}^2$  (or the area of the surface if less than  $300 \text{ cm}^2$ ) does not exceed  $4 \times 10^4 \text{ Bq}/\text{cm}^2$  ( $1 \text{ FCi}/\text{cm}^2$ ) for beta and gamma and low toxicity alpha emitters, or  $4 \times 10^3 \text{ Bq}/\text{cm}^2$  ( $10^{-1} \text{ FCi}/\text{cm}^2$ ) for all other alpha emitters; and

(iii) the non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over  $300 \text{ cm}^2$  (or the area of the surface if less than  $300 \text{ cm}^2$ ) does not exceed  $4 \times 10^4 \text{ Bq}/\text{cm}^2$  ( $1 \text{ FCi}/\text{cm}^2$ ) for beta and gamma and low toxicity alpha emitters, or  $4 \times 10^3 \text{ Bq}/\text{cm}^2$  ( $10^{-1} \text{ FCi}/\text{cm}^2$ ) for all other alpha emitters.

(B) SCO-II: A solid object on which the limits for SCO-I are exceeded and on which the following limits are not exceeded:

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(i) the non-fixed contamination on the accessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 400 Bq/cm<sup>2</sup> (10<sup>-2</sup> FCi/cm<sup>2</sup>) for beta and gamma and low toxicity alpha emitters or 40 Bq/cm<sup>2</sup> (10<sup>-3</sup> FCi/cm<sup>2</sup>) for all other alpha emitters;

(ii) the fixed contamination on the accessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 8x10<sup>5</sup> Bq/cm<sup>2</sup> (20 FCi/cm<sup>2</sup>) for beta and gamma and low toxicity alpha emitters, or 8x10<sup>4</sup> Bq/cm<sup>2</sup> (2 FCi/cm<sup>2</sup>) for all other alpha emitters; and

(iii) the non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 8 x 10<sup>5</sup> Bq/cm<sup>2</sup> (20 FCi/cm<sup>2</sup>) for beta and gamma and low toxicity alpha emitters, or 8 x 10<sup>4</sup> Bq/cm<sup>2</sup> (2 FCi/cm<sup>2</sup>) for all other alpha emitters.

(33) Uniform Low-Level Radioactive Waste Manifest or uniform manifest - The combination of BRC Forms 540, 541, and, if necessary, 542, and their respective continuation sheets as needed, or equivalent.

(34) Uranium - Natural, depleted, enriched:

(A) Natural uranium - Uranium with the naturally occurring distribution of uranium isotopes (approximately 0.711 weight percent uranium-235, and the remainder by weight essentially uranium-238).

(B) Depleted uranium - Uranium containing less uranium-235 than the naturally occurring distribution of uranium isotopes.

(C) Enriched uranium - Uranium containing more uranium-235 than the naturally occurring distribution of uranium isotopes.

(35) Waste collector - An entity, operating under a NRC, agreement state, or agency license, whose principal purpose is to collect and consolidate waste generated by others, and to transfer this waste, without processing or repackaging the collected waste, to another licensed waste collector, licensed waste processor, or licensed land disposal facility.

(36) Waste description - The physical, chemical and radiological description of a LLRW as called for on BRC Form 541.

(37) Waste generator - An entity, operating under a NRC, agreement state, or agency license, who:

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(A) possesses any material or component that contains radioactivity or is radioactively contaminated for which the licensee foresees no further use; and

(B) transfers this material or component to a licensed land disposal facility or to a licensed waste collector or processor for handling or treatment prior to disposal. A licensee performing processing or decontamination services may be a waste generator if the transfer of LLRW from its facility is defined as residual waste.

(38) Waste processor - An entity, operating under a NRC or agreement state license, whose principal purpose is to process, repackage, or otherwise treat LLRW or waste generated by others prior to eventual transfer of waste to a licensed LLRW land disposal facility.

(39) Waste type - A waste within a disposal container having a unique physical description (i.e., a specific waste descriptor code or description; or a waste sorbed on or solidified in a specifically-defined media).

(e) Transportation of radioactive material.

(1) Each licensee who transports radioactive material outside the site of usage as specified in the agency license, transports on public highways, or delivers radioactive material to a carrier for transport, shall comply with the applicable requirements of the DOT regulations in 49 CFR Parts 170-189 and 397 appropriate to the mode of transport. The licensee shall comply with the following, particularly noting DOT regulations as applicable in the following areas:

(A) Packaging - 49 CFR Part 173: Subparts A, B, and I.

(B) Marking and labeling - 49 CFR Part 172: Subpart D, §§172.400 - 172.407, §§172.436 - 172.440, and Subpart E.

(C) Placarding - 49 CFR Part 172: Subpart F, especially §§172.500 - 172.519, §172.556, and Appendices B and C.

(D) Accident reporting - 49 CFR Part 171: §171.15 and §171.16.

(E) Shipping papers and emergency information - 49 CFR Part 172: Subparts C and G.

(F) Hazardous material employee training - 49 CFR Part 172: Subpart H.

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(G) Hazardous material shipper/carrier registration - 49 CFR Part 107:  
Subpart G.

(H) Routing - 49 CFR Part 397: Subpart D.

(2) If DOT regulations are not applicable to a shipment of radioactive material, the licensee shall conform to DOT standards and requirements specified in paragraph (1) of this subsection to the same extent as if the shipment or transportation were subject to DOT regulations. A request for modification, waiver, or exemption from those requirements must be filed and approved by the agency. Any notification referred to in those requirements, must be submitted to the agency.

(f) Exemption for low-level radioactive materials.

(1) A licensee is exempt from all requirements of this section with respect to shipment or carriage of a package containing radioactive material having a specific activity not greater than 70 becquerels per gram (Bq/g) (0.002 microcuries per gram (FCi/g)).

(2) A licensee is exempt from all requirements of this section, other than subsections (e) and (i) of this section, with respect to shipment or carriage of the following packages, provided the packages contain no fissile material, or the fissile material exemption standards of 10 CFR 71.53 are satisfied:

(A) a package containing no more than a Type A quantity of radioactive material;

(B) a package in which the only radioactive material is LSA material or SCO, provided the external radiation level at 3 m from the unshielded material or objects does not exceed 10 millisieverts per hour (mSv/hr) (1 rem per hour (rem/hr)); or

(C) a package transported within locations within the United States which contains only americium or plutonium in special form with an aggregate radioactivity not to exceed 20 Ci.

(3) A licensee is exempt from all requirements of this section, other than subsections (e) and (i) of this section, with respect to shipment or carriage of LSA material in group LSA-I, or SCOs in group SCO-I.

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(4) Common and contract carriers, freight forwarders, and warehousemen, who are subject to the rules and regulations of the DOT or the United States Postal Service (39 CFR Parts 14 and 15), are exempt from these regulations to the extent that they transport or store sources of radiation in the regular course of their carriage for another or storage incident thereto. Private carriers who are subject to the rules and regulations of the DOT are exempted from these regulations to the extent that they transport sources of radiation. Common, contract, and private carriers who are not subject to the rules and regulations of the DOT or the United States Postal Service are subject to applicable sections of these regulations.

(5) Persons who discard licensed material in accordance with §289.202(fff) of this title are exempt from all requirements of this section.

(g) General license.

(1) NRC-approved package.

(A) A general license is hereby issued to any licensee of the agency to transport, or to deliver to a carrier for transport, radioactive material in a package for which a license, certificate of compliance, or other approval has been issued by the NRC.

(B) This general license applies only to a licensee who has a quality assurance program approved by the NRC as satisfying the provisions of 10 CFR 71.

(C) This general license applies only to a licensee who meets the following requirements:

(i) has a copy of the specific license, certificate of compliance, or other approval by the NRC of the package, and has the drawings and other documents referenced in the approval relating to the use and maintenance of the packaging and to the actions to be taken before shipment; and

(ii) complies with the terms and conditions of the specific license, certificate, or other approval by the NRC, as applicable, and the applicable requirements of 10 CFR 71;

(D) For radiography containers, a program for transport container inspection and maintenance limited to radiographic exposure devices, source changers, or packages transporting these devices and meeting the requirements of §289.255(i)(2)(B) of this title (relating to Radiation Safety Requirements and Licensing and Registration Procedures for Industrial Radiography), is deemed to satisfy the requirements of subparagraph (B) of this paragraph.

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(2) Previously approved package.

(A) A Type B package previously approved by the NRC, but not designated as B(U) or B(M) in the identification number of the NRC certificate of compliance, may be used under the general license of paragraph (1) of this subsection with the following additional conditions:

(i) fabrication of the packaging was satisfactorily completed before August 31, 1986, as demonstrated by application of its model number in accordance with NRC regulations at 10 CFR 71.85(c);

(ii) a package used for a shipment to a location outside the United States is subject to multilateral approval, as defined in DOT regulations at 49 CFR 173.403; and

(iii) a serial number that uniquely identifies each packaging which conforms to the approved design is assigned to, and legibly and durably marked on, the outside of each packaging.

(B) A Type B(U) package, a Type B(M) package, a LSA material package or a fissile material package, previously approved by the NRC but without the designation "-85" in the identification number of the NRC certificate of compliance, may be used under the general license of paragraph (1) of this subsection with the following additional conditions:

(i) fabrication of the package is satisfactorily completed by April 1, 1999, as demonstrated by application of its model number in accordance with NRC regulations at 10 CFR 71.85(c);

(ii) a package used for a shipment to a location outside the United States is subject to multilateral approval except approved under special arrangement in accordance with DOT regulations at 49 CFR 173.403; and

(iii) a serial number which uniquely identifies each packaging which conforms to the approved design is assigned to and legibly and durably marked on the outside of each packaging.

(3) DOT specification container.

(A) A general license is issued to any licensee to transport, or to deliver to a carrier for transport, licensed material in a specification container for fissile material or for a Type B quantity of radioactive material as specified in 49 CFR Parts 173 and 178.

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(B) This general license applies only to a licensee who:

(i) has a copy of the specification;

(ii) complies with the terms and conditions of the specification and the applicable requirements of this section; and

(iii) has a quality assurance program required by 10 CFR 71.105.

(C) The general license in subparagraph (A) of this paragraph is subject to the limitation that the specification container may not be used for a shipment to a location outside the United States except by multilateral approval as defined in 49 CFR 173.403.

(4) Use of foreign approved package.

(A) A general license is issued to any licensee to transport, or to deliver to a carrier for transport, licensed material in a package the design of which has been approved in a foreign national competent authority certificate which has been revalidated by the DOT as meeting the applicable requirements of 49 CFR 171.12.

(B) This general license applies only to international shipments.

(C) This general license applies only to a licensee who:

(i) has a copy of the applicable certificate, the revalidation, and the drawings and other documents referenced in the certificate relating to the use and maintenance of the packaging and to the actions to be taken prior to shipment;

(ii) complies with the terms and conditions of the certificate and revalidation, and with the applicable requirements of this section; and

(iii) the licensee has a quality assurance program approved by the NRC.

(h) Routine determinations. Before each shipment of radioactive material, the licensee shall ensure that the package with its contents satisfies the applicable requirements of this section and of the license. The licensee shall determine that:

(1) the package is proper for the contents to be shipped;

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(2) the package is in unimpaired physical condition except for superficial defects such as marks or dents;

(3) each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects;

(4) any system for containing liquid is adequately sealed and has adequate space or other specified provision for expansion of the liquid;

(5) any pressure relief device is operable and set in accordance with written procedures;

(6) the package has been loaded and closed in accordance with written procedures;

(7) any structural part of the package that could be used to lift or tie down the package during transport is rendered inoperable for that purpose, unless it satisfies the design requirements of 10 CFR 71.45;

(8) the level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment is as low as reasonably achievable (ALARA), and within the limits specified in DOT regulations in 49 CFR 173.443;

(9) external radiation levels around the package and around the vehicle, if applicable, will not exceed the following limits at any time during transportation:

(A) Except as provided in subparagraph (B) of this paragraph, each package of radioactive materials offered for transportation must be designed and prepared for shipment so that under conditions normally incident to transportation the radiation level does not exceed 2 mSv/hr (200 mrem/hr) at any point on the external surface of the package, and the transport index does not exceed 10.

(B) A package that exceeds the radiation level limits specified in subparagraph (A) of this paragraph must be transported by exclusive use shipment only, and the radiation levels for such shipment must not exceed the following during transportation:

(i) 2 mSv/hr (200 mrem/hr) on the accessible external surface of the package, unless the following conditions are met, in which case the limit is 10 mSv/hr (1,000 mrem/hr):

(I) the shipment is made in a closed transport vehicle;



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(II) the package is secured within the vehicle so that its position remains fixed during transportation; and

(III) there are no loading or unloading operations between the beginning and end of the transportation;

(ii) 2 mSv/hr (200 mrem/hr) at any point on the outer surface of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load or enclosure, if used, and on the lower external surface of the vehicle; and

(iii) 0.1 mSv/hr (10 mrem/hr) at any point 2 meters (m) (6.6 feet (ft)) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2 m (6.6 ft) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle); and

(iv) 0.02 mSv/hr (2 mrem/hr) in any normally occupied space, except that this provision does not apply to private carriers, if exposed personnel under their control wear radiation dosimetry devices in conformance with §289.202(q) of this title;

(10) a package must be designed, constructed, and prepared for transport so that in still air at 38 degrees Celsius (100 degrees Fahrenheit) and in the shade, no accessible surface of a package would have a temperature exceeding 50 degrees Celsius (122 degrees Fahrenheit) in a nonexclusive use shipment, or 85 degrees Celsius (185 degrees Fahrenheit) in an exclusive use shipment. Accessible package surface temperatures shall not exceed these limits at any time during transportation; and

(11) a package must not incorporate a feature intended to allow continuous venting during transport.

(i) Air transport of plutonium.

(1) Notwithstanding the provisions of any general licenses and notwithstanding any exemptions stated directly in this section or included indirectly by citation of 49 CFR Chapter 1, as may be applicable, the licensee shall assure that plutonium in any form, whether for import, export, or domestic shipment, is not transported by air or delivered to a carrier for air transport unless:

(A) the plutonium is contained in a medical device designed for individual human application; or

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(B) the plutonium is contained in a material in which the specific activity is not greater than 0.002  $\mu\text{Ci/g}$  (70 Bq/g) of material and in which the radioactivity is essentially uniformly distributed; or

(C) the plutonium is shipped in a single package containing no more than an  $A_2$  quantity of plutonium in any isotope or form, and is shipped in accordance with subsection (e) of this section; or

(D) the plutonium is shipped in a package specifically authorized for the shipment of plutonium by air in the Certificate of Compliance for that package issued by the NRC.

(2) Nothing in paragraph (1) of this subsection is to be interpreted as removing or diminishing the requirements of 10 CFR 73.24.

(3) For a shipment of plutonium by air which is subject to paragraph (1) of this subsection, the licensee shall, through special arrangement with the carrier, require compliance with 49 CFR 175.704, DOT regulations applicable to the air transport of plutonium.

(j) Opening instructions. Before delivery of a package to a carrier for transport, the licensee shall ensure that any special instructions needed to safely open the package have been sent to, or otherwise made available to, the consignee for the consignee's use in accordance with §289.202(ee)(5) of this title.

(k) Records. Each licensee shall maintain, for a period of three years after shipment, a record of each shipment of radioactive material showing the following where applicable:

- (1) identification of the packaging by model number and serial number;
- (2) verification that there are no significant defects in the packaging, as shipped;
- (3) type and quantity of radioactive material in each package, and the total quantity of each shipment;
- (4) date of the shipment;
- (5) for fissile packages and for Type B packages, any special controls exercised;
- (6) name and address of the transferee;
- (7) address to which the shipment was made; and

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(8) surveys performed to determine compliance with subsection (h)(8) and (9) of this section.

(l) Reports. The shipper shall immediately report by telephone, telegram, mailgram, or facsimile, all radioactive waste transportation accidents to the agency and the local emergency planning committees in the county where the radioactive waste accident occurs. All other accidents involving radioactive material shall be reported in accordance with §289.202(xx) and (yy) of this title.

(m) Advance notification of transport of certain radioactive waste.

(1) As specified in paragraphs (2)-(4) of this subsection, each licensee shall provide advance notification to the governor of a state, or the governor's designee, of the shipment of radioactive waste, through, or across the boundary of the state, before the transport, or delivery to a carrier, for transport, of radioactive waste outside the confines of the licensee's facility or other place of use or storage.

(2) Advance notification is required under this section for shipment of radioactive waste when the following three conditions are met:

(A) the radioactive waste is required by this section to be in Type B packaging for transportation;

(B) the radioactive waste is being transported to or across a state boundary en route to a disposal facility or to a collection point for transport to a disposal facility; and

(C) the quantity of radioactive waste in a single package exceeds the least of the following:

(i) 3000 times the  $A_1$  value of the radionuclides as specified in subsection (vv)(2) of this section for special form radioactive material;

(ii) 3000 times the  $A_2$  value of the radionuclides as specified in subsection (vv)(2) of this section for normal form radioactive material; or

(iii) 1000 terabecquerels (TBq) (27,000 curies (Ci)).

(3) The following are procedures for submitting advance notification:

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(A) The notification must be made in writing to the office of each appropriate governor or governor's designee and to the agency.

(B) A notification delivered by mail must be postmarked at least seven days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

(C) A notification delivered by messenger must reach the office of the governor or of the governor's designee at least four days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

(i) A list of the names and mailing addresses of the governors' designees receiving advance notification of transportation of radioactive waste was published in the Federal Register on June 30, 1995 (60 FR 34306).

(ii) The list will be published annually in the Federal Register on or about June 30 to reflect any changes in information.

(iii) A list of the names and mailing addresses of the governors' designees is available on request from the Director, Office of State Programs, United States Nuclear Regulatory Commission, Washington, DC 20555.

(D) The licensee shall retain a copy of the notification as a record for three years.

(4) Each advance notification of shipment of radioactive waste must contain the following information:

(A) the name, address, and telephone number of the shipper, carrier, and receiver of the radioactive waste shipment;

(B) a description of the radioactive waste contained in the shipment, as specified in the regulations of DOT in 49 CFR Part 172, §172.202 and §172.203(d);

(C) the point of origin of the shipment and the seven-day period during which departure of the shipment is estimated to occur;

(D) the seven-day period during which arrival of the shipment at state boundaries is estimated to occur;

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(E) the destination of the shipment, and the seven-day period during which arrival of the shipment is estimated to occur; and

(F) a point of contact, with a telephone number, for current shipment information.

(5) A licensee who finds that schedule information previously furnished to a governor or governor's designee, in accordance with this section, will not be met, shall telephone a responsible individual in the office of the governor of the state or of the governor's designee and inform that individual of the extent of the delay beyond the schedule originally reported. The licensee shall maintain a record of the date, time, and name of the individual contacted for three years.

(6) The following are procedures for a cancellation notice.

(A) Each licensee who cancels a radioactive waste shipment for which advance notification has been sent shall send a cancellation notice to the governor of each state or to the governor's designee previously notified, and to the agency.

(B) The licensee shall state in the notice that it is a cancellation and identify the advance notification that is being canceled. The licensee shall retain a copy of the notice as a record for three years.

(n) Emergency plan. Each shipper and transporter of radioactive waste shall adopt an emergency plan approved by the agency for responding to transportation accidents.

(o) Inspections. Each shipment of LLRW to a licensed land disposal facility in Texas shall be inspected by the agency prior to shipment. The waste shipper shall notify the agency no less than 72 hours prior to the scheduled shipment of the intent to transport waste to the licensed land disposal facility.

(p) Quality control program. Each shipper shall adopt a quality control program to include verification of the following to ensure that shipping containers are suitable for shipments to a licensed disposal facility:

- (1) identification of appropriate container(s);
- (2) container testing documentation is adequate;
- (3) appropriate container used;

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- (4) container packaged appropriately;
- (5) container labeled appropriately;
- (6) manifest filled out appropriately; and
- (7) documentation maintained of each step.

(q) Transfer for disposal and manifests.

(1) The requirements of this section and subsection (s)(5) of this section are designed to:

(A) control transfers of LLRW by any waste generator, waste collector, or waste processor licensee, as defined in this section, who ships LLRW either directly, or indirectly through a waste collector or waste processor, to a licensed LLRW land disposal facility, as defined in §289.201(b) of this title;

(B) establish a manifest tracking system; and

(C) supplement existing requirements concerning transfers and recordkeeping for those wastes.

(2) Beginning March 1, 1998, all affected licensees must use subsection (s)(5) of this section.

(3) Each shipment of LLRW intended for disposal at a licensed land disposal facility must be accompanied by a shipment manifest in accordance with subsection (s)(5)(A) of this section.

(4) Any licensee shipping LLRW intended for ultimate disposal at a licensed land disposal facility must document the information required on the uniform manifest and transfer this recorded manifest information to the intended consignee in accordance with subsection (s)(5) of this section.

(5) Each shipment manifest must include a certification by the waste generator as specified in subsection (s)(5)(J) of this section, as appropriate.

(6) Each person involved in the transfer for disposal and disposal of LLRW, including the waste generator, waste collector, waste processor, and disposal facility operator, shall comply with the requirements specified in subsection (s)(5)(K) of this section, as appropriate.

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(7) Any licensee shipping LLRW to a licensed Texas LLRW disposal facility shall comply with the waste acceptance criteria in 31 TAC §§451.21-451.29.

(r) Fees.

(1) Each shipper shall be assessed a fee for shipments of LLRW originating in Texas or out-of-state being shipped to a licensed Texas LLRW disposal facility and these fees shall be:

(A) \$10 per cubic foot of shipped LLRW;

(B) collected by the **Commission** and deposited to the credit of the radiation and perpetual care fund; and

(C) used exclusively by the agency for emergency planning for and response to transportation accidents involving LLRW.

(2) Fee assessments under this section shall be suspended when the amount of fees collected reaches \$500,000, except that if the balance of fees collected is reduced to \$350,000 or less, the assessments shall be reinstated to bring the balance of fees collected to \$500,000.

(3) Money expended from the radiation and perpetual care fund to respond to accidents involving LLRW must be reimbursed to the radiation and perpetual care fund by the responsible shipper or transporter according to rules adopted by the board.

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§289.257(s)

(s) Appendices.

(1) Determination of  $A_1$  and  $A_2$ .

(A) Values of  $A_1$  and  $A_2$  for individual radionuclides, which are the bases for many activity limits elsewhere in these rules are given in paragraph (2) of this subsection. The curie (Ci) values specified are obtained by converting from the terabecquerel (TBq) figure. The curie values are expressed to three significant figures to assure that the difference in the TBq and Ci quantities is one tenth of 1.0% or less. Where values of  $A_1$  or  $A_2$  are unlimited, it is for radiation control purposes only. For nuclear criticality safety, some materials are subject to controls placed on fissile material.

(B) For individual radionuclides whose identities are known, but which are not listed in paragraph (2) of this subsection, the determination of the values of  $A_1$  and  $A_2$  requires NRC approval, except that the values of  $A_1$  and  $A_2$  in paragraph (3) of this subsection may be used without obtaining NRC approval.

(C) In the calculations of  $A_1$  and  $A_2$  for a radionuclide not in paragraph (2) of this subsection, a single radioactive decay chain, in which radionuclides are present in their naturally occurring proportions, and in which no daughter nuclide has a half-life either longer than ten days, or longer than that of the parent nuclide, shall be considered as a single radionuclide, and the activity to be taken into account and the  $A_1$  or  $A_2$  value to be applied shall be those corresponding to the parent nuclide of that chain. In the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than ten days, or greater than that of the parent nuclide, the parent and those daughter nuclides shall be considered as mixtures of different nuclides.

(D) For mixtures of radionuclides whose identities and respective activities are known, the following conditions apply.

(i) For special form radioactive material, the maximum quantity transported in a Type A package:

$$\sum_i \frac{B(i)}{A_1(i)} \leq 1$$

(ii) For normal form radioactive material, the maximum quantity transported in a Type A package:

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$$A_1 \text{ for mixture } = \frac{B(i)}{A_2(i)}$$

where B(i) is the activity of radionuclide i and A<sub>1</sub>(i) and A<sub>2</sub>(i) are the A<sub>1</sub> and A<sub>2</sub> values for radionuclide i, respectively.

(iii) Alternatively, an A<sub>1</sub> value for mixtures of special form material may be determined as follows:

$$A_1 \text{ for mixture } = \frac{1}{\sum_i \frac{f(i)}{A_1(i)}}$$

where f(i) is the fraction of activity of nuclide i in the mixture and A<sub>1</sub>(i) is the appropriate A<sub>1</sub> value for nuclide i.

(iv) An A<sub>2</sub> value for mixtures of normal form material may be determined as follows:

$$A_2 \text{ for mixture } = \frac{1}{\sum_i \frac{f(i)}{A_2(i)}}$$

where f(i) is the fraction of activity of nuclide i in the mixture and A<sub>2</sub>(i) is the appropriate A<sub>2</sub> value for nuclide i.

(E) When the identity of each radionuclide is known, but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest A<sub>1</sub> or A<sub>2</sub> value, as appropriate, for the radionuclides in each group may be used in applying the formulas in subparagraph (D) of this paragraph. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest A<sub>1</sub> or A<sub>2</sub> values for the alpha emitters and beta/gamma emitters.

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(2)  $A_1$  and  $A_2$  values for radionuclides. The following table contains  $A_1$  and  $A_2$  values for radionuclides:

Symbol of Radionuclide	Element and Atomic Number	$A_1$ (TBq)	$A_1$ (Ci)	$A_2$ (TBq)	$A_2$ (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
Ac-225	Actinium(89)	0.6	16.2	$1 \times 10^{-2}$	0.270	$2.1 \times 10^3$	$5.8 \times 10^4$
Ac-227		40	1080	$2 \times 10^{-5}$	$5.41 \times 10^{-4}$	2.7	$7.2 \times 10^1$
Ac-228		0.6	16.2	0.4	10.8	$8.4 \times 10^4$	$2.2 \times 10^6$
Ag-105	Silver(47)	2	54.1	2	54.1	$1.1 \times 10^3$	$3.0 \times 10^4$
Ag-108m		0.6	16.2	0.6	16.2	$9.7 \times 10^{-1}$	$2.6 \times 10^1$
Ag-110m		0.4	10.8	0.4	10.8	$1.8 \times 10^2$	$4.7 \times 10^3$
Ag-111	Aluminum(13)	0.6	16.2	0.5	13.5	$5.8 \times 10^3$	$1.6 \times 10^5$
Al-26		0.4	10.8	0.4	10.8	$7.0 \times 10^{-4}$	$1.9 \times 10^{-2}$
Am-241		Americium(95)	2	54.1	$2 \times 10^{-4}$	$5.41 \times 10^{-3}$	$1.3 \times 10^{-1}$
Am-242m	2		54.1	$2 \times 10^{-4}$	$5.41 \times 10^{-3}$	$3.6 \times 10^{-1}$	$1.0 \times 10^1$
Am-243	2		54.1	$2 \times 10^{-4}$	$5.41 \times 10^{-3}$	$7.4 \times 10^{-3}$	$2.0 \times 10^{-1}$
Ar-37	Argon(18)	40	1080	40	1080	$3.7 \times 10^3$	$9.9 \times 10^4$
Ar-39		20	541	20	541	1.3	$3.4 \times 10^1$
Ar-41		0.6	16.2	0.6	16.2	$1.5 \times 10^6$	$4.2 \times 10^7$
Ar-42	Arsenic(33)	0.2	5.41	0.2	5.41	9.6	$2.6 \times 10^2$
As-72		0.2	5.41	0.2	5.41	$6.2 \times 10^4$	$1.7 \times 10^6$
As-73		40	1080	40	1080	$8.2 \times 10^2$	$2.2 \times 10^4$
As-74	Astatine(85)	1	27.0	0.5	13.5	$3.7 \times 10^3$	$9.9 \times 10^4$
As-76		0.2	5.41	0.2	5.41	$5.8 \times 10^4$	$1.6 \times 10^6$
As-77		20	541	0.5	13.5	$3.9 \times 10^4$	$1.0 \times 10^6$
At-211	Gold(79)	30	811	2	54.1	$7.6 \times 10^4$	$2.1 \times 10^6$
Au-193		6	162	6	162	$3.4 \times 10^4$	$9.2 \times 10^5$
Au-194		1	27.0	1	27.0	$1.5 \times 10^4$	$4.1 \times 10^5$
Au-195	Barium(56)	10	270	10	270	$1.4 \times 10^2$	$3.7 \times 10^3$
Au-196		2	54.1	2	54.1	$4.0 \times 10^3$	$1.1 \times 10^5$
Au-198		3	81.1	0.5	13.5	$9.0 \times 10^3$	$2.4 \times 10^5$
Au-199	Barium(56)	10	270	0.9	24.3	$7.7 \times 10^3$	$2.1 \times 10^5$
Ba-131		2	54.1	2	54.1	$3.1 \times 10^3$	$8.4 \times 10^4$

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
Ba-133m		10	270	0.9	24.3	2.2x10 <sup>4</sup>	6.1x10 <sup>5</sup>
Ba-133		3	81.1	3	81.1	9.4	2.6x10 <sup>2</sup>
Ba-140		0.4	10.8	0.4	10.8	2.7x10 <sup>3</sup>	7.3x10 <sup>4</sup>
Be-7	Beryllium(4)	20	541	20	541	1.3x10 <sup>4</sup>	3.5x10 <sup>5</sup>
Be-10		20	541	0.5	13.5	8.3x10 <sup>-4</sup>	2.2x10 <sup>-2</sup>
Bi-205	Bismuth(83)	0.6	16.2	0.6	16.2	1.5x10 <sup>3</sup>	4.2x10 <sup>4</sup>
Bi-206		0.3	8.11	0.3	8.11	3.8x10 <sup>3</sup>	1.0x10 <sup>5</sup>
Bi-207		0.7	18.9	0.7	18.9	1.9	5.2x10 <sup>1</sup>
Bi-210m		0.3	8.11	3x10 <sup>-2</sup>	0.811	2.1x10 <sup>-5</sup>	5.7x10 <sup>-4</sup>
Bi-210		0.6	16.2	0.5	13.5	4.6x10 <sup>3</sup>	1.2x10 <sup>5</sup>
Bi-212		0.3	8.11	0.3	8.11	5.4x10 <sup>5</sup>	1.5x10 <sup>7</sup>
Bk-247	Berkelium(97)	2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	3.8x10 <sup>-2</sup>	1.0
Bk-249		40	1080	8x10 <sup>-2</sup>	2.16	6.1x10 <sup>1</sup>	1.6x10 <sup>3</sup>
Br-76	Bromine(35)	0.3	8.11	0.3	8.11	9.4x10 <sup>4</sup>	2.5x10 <sup>6</sup>
Br-77		3	81.1	3	81.1	2.6x10 <sup>4</sup>	7.1x10 <sup>5</sup>
Br-82		0.4	10.8	0.4	10.8	4.0x10 <sup>4</sup>	1.1x10 <sup>6</sup>
C-11	Carbon(6)	1	27	0.5	13.5	3.1x10 <sup>7</sup>	8.4x10 <sup>8</sup>
C-14		40	1080	2	54.1	1.6x10 <sup>-1</sup>	4.5
Ca-41	Calcium(20)	40	1080	40	1080	3.1x10 <sup>-3</sup>	8.5x10 <sup>-2</sup>
Ca-45		40	1080	0.9	24.3	6.6x10 <sup>2</sup>	1.8x10 <sup>4</sup>
Ca-47		0.9	24.3	0.5	13.5	2.3x10 <sup>4</sup>	6.1x10 <sup>5</sup>
Cd-109	Cadmium(48)	40	1080	1	27.0	9.6x10 <sup>1</sup>	2.6x10 <sup>3</sup>
Cd-113m		20	541	9x10 <sup>-2</sup>	2.43	8.3	2.2x10 <sup>2</sup>
Cd-115m		0.3	8.11	0.3	8.11	9.4x10 <sup>2</sup>	2.5x10 <sup>4</sup>
Cd-115		4	108	0.5	13.5	1.9x10 <sup>4</sup>	5.1x10 <sup>5</sup>
Ce-139	Cerium(58)	6	162	6	162	2.5x10 <sup>2</sup>	6.8x10 <sup>3</sup>
Ce-141		10	270	0.5	13.5	1.1x10 <sup>3</sup>	2.8x10 <sup>4</sup>

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>2</sub>	Specific Activity	
		(TBq)	(Ci)	(TBq)	(Ci)	(TBq/g)	(Ci/g)
Ce-143		0.6	16.2	0.5	13.5	2.5x10 <sup>4</sup>	6.6x10 <sup>5</sup>
Ce-144		0.2	5.41	0.2	5.41	1.2x10 <sup>2</sup>	3.2x10 <sup>3</sup>
Cf-248	Californium(98)	30	811	3x10 <sup>-3</sup>	8.11x10 <sup>-2</sup>	5.8x10 <sup>1</sup>	1.6x10 <sup>3</sup>
Cf-249		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	1.5x10 <sup>-1</sup>	4.1
Cf-250		5	135	5x10 <sup>-4</sup>	1.35x10 <sup>-2</sup>	4.0	1.1x10 <sup>2</sup>
Cf-251		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	5.9x10 <sup>-2</sup>	1.6
Cf-252		0.1	2.70	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	2.0x10 <sup>1</sup>	5.4x10 <sup>2</sup>
Cf-253		40	1080	6x10 <sup>-2</sup>	1.62	1.1x10 <sup>3</sup>	2.9x10 <sup>4</sup>
Cf-254		3x10 <sup>-3</sup>	8.11x10 <sup>-2</sup>	6x10 <sup>-4</sup>	1.62x10 <sup>-2</sup>	3.1x10 <sup>2</sup>	8.5x10 <sup>3</sup>
Cl-36		Chlorine(17)	20	541	0.5	13.5	1.2x10 <sup>-3</sup>
Cl-38	0.2		5.41	0.2	5.41	4.9x10 <sup>6</sup>	1.3x10 <sup>8</sup>
Cm-240	Curium(96)	40	1080	2x10 <sup>-2</sup>	0.541	7.5x10 <sup>2</sup>	2.0x10 <sup>4</sup>
Cm-241		2	54.1	0.9	24.3	6.1x10 <sup>2</sup>	1.7x10 <sup>4</sup>
Cm-242		40	1080	1x10 <sup>-2</sup>	0.270	1.2x10 <sup>2</sup>	3.3x10 <sup>3</sup>
Cm-243		3	81.1	3x10 <sup>-4</sup>	8.11x10 <sup>-3</sup>	1.9	5.2x10 <sup>1</sup>
Cm-244		4	108	4x10 <sup>-4</sup>	1.08x10 <sup>-2</sup>	3.0	8.1x10 <sup>5</sup>
Cm-245		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	6.4x10 <sup>-3</sup>	1.7x10 <sup>-1</sup>
Cm-246		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	1.1x10 <sup>-2</sup>	3.1x10 <sup>-1</sup>
Cm-247		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	3.4x10 <sup>-6</sup>	9.3x10 <sup>-5</sup>
Cm-248		4x10 <sup>-2</sup>	1.08	5x10 <sup>-5</sup>	1.35x10 <sup>-3</sup>	1.6x10 <sup>-4</sup>	4.2x10 <sup>-3</sup>
Co-55		Cobalt(27)	0.5	13.5	0.5	13.5	1.1x10 <sup>5</sup>
Co-56	0.3		8.11	0.3	8.11	1.1x10 <sup>3</sup>	3.0x10 <sup>4</sup>
Co-57	8		216	8	216	3.1x10 <sup>2</sup>	8.4x10 <sup>3</sup>
Co-58m	40		1080	40	1080	2.2x10 <sup>5</sup>	5.9x10 <sup>6</sup>
Co-58	1		27.0	1	27.0	1.2x10 <sup>3</sup>	3.2x10 <sup>4</sup>
Co-60		0.4	10.8	0.4	10.8	4.2x10 <sup>1</sup>	1.1x10 <sup>3</sup>
Cr-51	Chromium(24)	30	811	30	811	3.4x10 <sup>3</sup>	9.2x10 <sup>4</sup>

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
Cs-129	Cesium(55)	4	108	4	108	2.8x10 <sup>4</sup>	7.6x10 <sup>5</sup>
Cs-131		40	1080	40	1080	3.8x10 <sup>3</sup>	1.0x10 <sup>5</sup>
Cs-132		1	27.0	1	27.0	5.7x10 <sup>3</sup>	1.5x10 <sup>5</sup>
Cs-134m		40	1080	9	243	3.0x10 <sup>5</sup>	8.0x10 <sup>6</sup>
Cs-134		0.6	16.2	0.5	13.5	4.8x10 <sup>1</sup>	1.3x10 <sup>3</sup>
Cs-135		40	1080	0.9	24.3	4.3x10 <sup>-5</sup>	1.2x10 <sup>-3</sup>
Cs-136		0.5	13.5	0.5	13.5	2.7x10 <sup>3</sup>	7.3x10 <sup>4</sup>
Cs-137	2	54.1	0.5	13.5	3.2	8.7x10 <sup>1</sup>	
Cu-64	Copper(29)	5	135	0.9	24.3	1.4x10 <sup>5</sup>	3.9x10 <sup>6</sup>
Cu-67		9	243	0.9	24.3	2.8x10 <sup>4</sup>	7.6x10 <sup>5</sup>
Dy-159	Dysprosium(66)	20	541	20	541	2.1x10 <sup>2</sup>	5.7x10 <sup>3</sup>
Dy-165		0.6	16.2	0.5	13.5	3.0x10 <sup>5</sup>	8.2x10 <sup>6</sup>
Dy-166		0.3	8.11	0.3	8.11	8.6x10 <sup>3</sup>	2.3x10 <sup>5</sup>
Er-169	Erbium(68)	40	1080	0.9	24.3	3.1x10 <sup>3</sup>	8.3x10 <sup>4</sup>
Er-171		0.6	16.2	0.5	13.5	9.0x10 <sup>4</sup>	2.4x10 <sup>6</sup>
Es-253	Einsteinium(99)*	200	5400	2x10 <sup>-2</sup>	5.41x10 <sup>-1</sup>	--	--
Es-254		30	811	3x10 <sup>-3</sup>	8.11x10 <sup>-2</sup>	--	--
Es-254m		0.6	16.2	0.4	10.8	--	--
Es-255		--	--	--	--	--	--
Eu-147	Europium(63)	2	54.1	2	54.1	1.4x10 <sup>3</sup>	3.7x10 <sup>4</sup>
Eu-148		0.5	13.5	0.5	13.5	6.0x10 <sup>2</sup>	1.6x10 <sup>4</sup>
Eu-149		20	541	20	541	3.5x10 <sup>2</sup>	9.4x10 <sup>3</sup>
Eu-150		0.7	18.9	0.7	18.9	6.1x10 <sup>4</sup>	1.6x10 <sup>6</sup>
Eu-152m		0.6	16.2	0.5	13.5	8.2x10 <sup>4</sup>	2.2x10 <sup>6</sup>
Eu-152		0.9	24.3	0.9	24.3	6.5	1.8x10 <sup>2</sup>
Eu-154		0.8	21.6	0.5	13.5	9.8	2.6x10 <sup>2</sup>

\* International shipments of Einsteinium require multilateral approval of A<sub>1</sub> and A<sub>2</sub> values.

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
Eu-155		20	541	2	54.1	1.8x10 <sup>1</sup>	4.9x10 <sup>2</sup>
Eu-156		0.6	16.2	0.5	13.5	2.0x10 <sup>3</sup>	5.5x10 <sup>4</sup>
F-18	Fluorine(9)	1	27.0	0.5	13.5	3.5x10 <sup>6</sup>	9.5x10 <sup>7</sup>
Fe-52	Iron(26)	0.2	5.41	0.2	5.41	2.7x10 <sup>5</sup>	7.3x10 <sup>6</sup>
Fe-55		40	1080	40	1080	8.8x10 <sup>1</sup>	2.4x10 <sup>3</sup>
Fe-59		0.8	21.6	0.8	21.6	1.8x10 <sup>3</sup>	5.0x10 <sup>4</sup>
Fe-60		40	1080	0.2	5.41	7.4x10 <sup>-4</sup>	2.0x10 <sup>-2</sup>
Fm-255	Fermium(100)*	40	1080	0.8	21.6	--	--
Fm-257		10	270	8x10 <sup>-3</sup>	2.16x10 <sup>-1</sup>	--	--
Ga-67	Gallium(31)	6	162	6	162	2.2x10 <sup>4</sup>	6.0x10 <sup>5</sup>
Ga-68		0.3	8.11	0.3	8.11	1.5x10 <sup>6</sup>	4.1x10 <sup>7</sup>
Ga-72		0.4	10.8	0.4	10.8	1.1x10 <sup>5</sup>	3.1x10 <sup>6</sup>
Gd-146	Gadolinium(64)	0.4	10.8	0.4	10.8	6.9x10 <sup>2</sup>	1.9x10 <sup>4</sup>
Gd-148		3	81.1	3x10 <sup>-4</sup>	8.11x10 <sup>-3</sup>	1.2	3.2x10 <sup>1</sup>
Gd-153		10	270	5	135	1.3x10 <sup>2</sup>	3.5x10 <sup>3</sup>
Gd-159		4	108	0.5	13.5	3.9x10 <sup>4</sup>	1.1x10 <sup>6</sup>
Ge-68	Germanium(32)	0.3	8.11	0.3	8.11	2.6x10 <sup>2</sup>	7.1x10 <sup>3</sup>
Ge-71		40	1080	40	1080	5.8x10 <sup>3</sup>	1.6x10 <sup>5</sup>
Ge-77		0.3	8.11	0.3	8.11	1.3x10 <sup>5</sup>	3.6x10 <sup>6</sup>
H-3	Hydrogen(1)	See T-Tritium					
Hf-172	Hafnium(72)	0.5	13.5	0.3	8.11	4.1x10 <sup>1</sup>	1.1x10 <sup>3</sup>
Hf-175		3	81.1	3	81.1	3.9x10 <sup>2</sup>	1.1x10 <sup>4</sup>
Hf-181		2	54.1	0.9	24.3	6.3x10 <sup>2</sup>	1.7x10 <sup>4</sup>
Hf-182		4	108	3x10 <sup>-2</sup>	0.811	8.1x10 <sup>-6</sup>	2.2x10 <sup>-4</sup>
Hg-194	Mercury(80)	1	27.0	1	27.0	1.3x10 <sup>-1</sup>	3.5
Hg-195m		5	135	5	135	1.5x10 <sup>4</sup>	4.0x10 <sup>5</sup>

\* International shipments of Fermium require multilateral approval of A<sub>1</sub> and A<sub>2</sub> values.

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
Hg-197m		10	270	0.9	24.3	2.5x10 <sup>4</sup>	6.7x10 <sup>5</sup>
Hg-197		10	270	10	270	9.2x10 <sup>3</sup>	2.5x10 <sup>5</sup>
Hg-203		4	108	0.9	24.3	5.1x10 <sup>2</sup>	1.4x10 <sup>4</sup>
Ho-163	Holmium(67)	40	1080	40	1080	2.7	7.6x10 <sup>1</sup>
Ho-166m		0.6	16.2	0.3	8.11	6.6x10 <sup>-2</sup>	1.8
Ho-166		0.3	8.11	0.3	8.11	2.6x10 <sup>4</sup>	7.0x10 <sup>5</sup>
I-123	Iodine(53)	6	162	6	162	7.1x10 <sup>4</sup>	1.9x10 <sup>6</sup>
I-124		0.9	24.3	0.9	24.3	9.3x10 <sup>3</sup>	2.5x10 <sup>5</sup>
I-125		20	541	2	54.1	6.4x10 <sup>2</sup>	1.7x10 <sup>4</sup>
I-126		2	54.1	0.9	24.3	2.9x10 <sup>3</sup>	8.0x10 <sup>4</sup>
I-129		Unlimited	Unlimited	Unlimited	Unlimited	6.5x10 <sup>-6</sup>	1.8x10 <sup>-4</sup>
I-131		3	81.1	0.5	13.5	4.6x10 <sup>3</sup>	1.2x10 <sup>5</sup>
I-132		0.4	10.8	0.4	10.8	3.8x10 <sup>5</sup>	1.0x10 <sup>7</sup>
I-133		0.6	16.2	0.5	13.5	4.2x10 <sup>4</sup>	1.1x10 <sup>6</sup>
I-134		0.3	8.11	0.3	8.11	9.9x10 <sup>5</sup>	2.7x10 <sup>7</sup>
I-135		0.6	16.2	0.5	13.5	1.3x10 <sup>5</sup>	3.5x10 <sup>6</sup>
In-111	Indium(49)	2	54.1	2	54.1	1.5x10 <sup>4</sup>	4.2x10 <sup>5</sup>
In-113m		4	108	4	108	6.2x10 <sup>5</sup>	1.7x10 <sup>7</sup>
In-114m		0.3	8.11	0.3	8.11	8.6x10 <sup>2</sup>	2.3x10 <sup>4</sup>
In-115m		6	162	0.9	24.3	2.2x10 <sup>5</sup>	6.1x10 <sup>6</sup>
Ir-189	Iridium(77)	10	270	10	270	1.9x10 <sup>3</sup>	5.2x10 <sup>4</sup>
Ir-190		0.7	18.9	0.7	18.9	2.3x10 <sup>3</sup>	6.2x10 <sup>4</sup>
Ir-192		1	27.0	0.5	13.5	3.4x10 <sup>2</sup>	9.2x10 <sup>3</sup>
Ir-193m		10	270	10	270	2.4x10 <sup>3</sup>	6.4x10 <sup>4</sup>
Ir-194		0.2	5.41	0.2	5.41	3.1x10 <sup>4</sup>	8.4x10 <sup>5</sup>
K-40	Potassium(19)	0.6	16.2	0.6	16.2	2.4x10 <sup>-7</sup>	6.4x10 <sup>-6</sup>
K-42		0.2	5.41	0.2	5.41	2.2x10 <sup>5</sup>	6.0x10 <sup>6</sup>
K-43		1.0	27.0	0.5	13.5	1.2x10 <sup>5</sup>	3.3x10 <sup>6</sup>



A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
Kr-81	Krypton(36)	40	1080	40	1080	7.8x10 <sup>-4</sup>	2.1x10 <sup>-2</sup>
Kr-85m		6	162	6	162	3.0x10 <sup>5</sup>	8.2x10 <sup>6</sup>
Kr-85		20	541	10	270	1.5x10 <sup>1</sup>	3.9x10 <sup>2</sup>
Kr-87		0.2	5.41	0.2	5.41	1.0x10 <sup>6</sup>	2.8x10 <sup>7</sup>
La-137	Lanthanum(57)	40	1080	2	54.1	1.6x10 <sup>-3</sup>	4.4x10 <sup>-2</sup>
La-140		0.4	10.8	0.4	10.8	2.1x10 <sup>4</sup>	5.6x10 <sup>5</sup>
Lu-172	Lutetium(71)	0.5	13.5	0.5	13.5	4.2x10 <sup>3</sup>	1.1x10 <sup>5</sup>
Lu-173		8	216	8	216	5.6x10 <sup>1</sup>	1.5x10 <sup>3</sup>
Lu-174m		20	541	8	216	2.0x10 <sup>2</sup>	5.3x10 <sup>3</sup>
Lu-174		8	216	4	108	2.3x10 <sup>1</sup>	6.2x10 <sup>2</sup>
Lu-177		30	811	0.9	24.3	4.1x10 <sup>3</sup>	1.1x10 <sup>5</sup>
MFP	For mixed fission products, use formula for mixtures or subsection (s)(3) of this section.						
Mg-28	Magnesium(12)	0.2	5.41	0.2	5.41	2.0x10 <sup>5</sup>	5.4x10 <sup>6</sup>
Mn-52	Manganese(25)	0.3	8.11	0.3	8.11	1.6x10 <sup>4</sup>	4.4x10 <sup>5</sup>
Mn-53		Unlimited	Unlimited	Unlimited	Unlimited	6.8x10 <sup>-5</sup>	1.8x10 <sup>-3</sup>
Mn-54		1	27.0	1	27.0	2.9x10 <sup>2</sup>	7.7x10 <sup>3</sup>
Mn-56		0.2	5.41	0.2	5.41	8.0x10 <sup>5</sup>	2.2x10 <sup>7</sup>
Mo-93	Molybdenum(42)	40	1080	7	189	4.1x10 <sup>-2</sup>	1.1
Mo-99		0.6	16.2	0.5	13.5*	1.8x10 <sup>4</sup>	4.8x10 <sup>5</sup>
N-13	Nitrogen(7)	0.6	16.2	0.5	13.5	5.4x10 <sup>7</sup>	1.5x10 <sup>9</sup>
Na-22	Sodium(11)	0.5	13.5	0.5	13.5	2.3x10 <sup>2</sup>	6.3x10 <sup>3</sup>
Na-24		0.2	5.41	0.2	5.41	3.2x10 <sup>5</sup>	8.7x10 <sup>6</sup>
Nb-92m	Niobium(41)	0.7	18.9	0.7	18.9	5.2x10 <sup>3</sup>	1.4x10 <sup>5</sup>
Nb-93m		40	1080	6	162	8.8	2.4x10 <sup>2</sup>
Nb-94		0.6	16.2	0.6	16.2	6.9x10 <sup>-3</sup>	1.9x10 <sup>-1</sup>
Nb-95		1	27.0	1	27.0	1.5x10 <sup>3</sup>	3.9x10 <sup>4</sup>

\* 20 Ci for Mo<sup>99</sup> for domestic use.

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub>		A <sub>2</sub>		Specific Activity	
		(TBq)	(Ci)	(TBq)	(Ci)	(TBq/g)	(Ci/g)
Nb-97		0.6	16.2	0.5	13.5	9.9x10 <sup>5</sup>	2.7x10 <sup>7</sup>
Nd-147	Neodymium(60)	4	108	0.5	13.5	3.0x10 <sup>3</sup>	8.1x10 <sup>4</sup>
Nd-149		0.6	16.2	0.5	13.5	4.5x10 <sup>5</sup>	1.2x10 <sup>7</sup>
Ni-59	Nickel(28)	40	1080	40	1080	3.0x10 <sup>-3</sup>	8.0x10 <sup>-2</sup>
Ni-63		40	1080	30	811	2.1	5.7x10 <sup>1</sup>
Ni-65		0.3	8.11	0.3	8.11	7.1x10 <sup>5</sup>	1.9x10 <sup>7</sup>
Np-235	Neptunium(93)	40	1080	40	1080	5.2x10 <sup>1</sup>	1.4x10 <sup>3</sup>
Np-236		7	189	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	4.7x10 <sup>-4</sup>	1.3x10 <sup>-2</sup>
Np-237		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	2.6x10 <sup>-5</sup>	7.1x10 <sup>-4</sup>
Np-239		6	162	0.5	13.5	8.6x10 <sup>3</sup>	2.3x10 <sup>5</sup>
Os-185	Osmium(76)	1	27.0	1	27.0	2.8x10 <sup>2</sup>	7.5x10 <sup>3</sup>
Os-191m		40	1080	40	1080	4.6x10 <sup>4</sup>	1.3x10 <sup>6</sup>
Os-191		10	270	0.9	24.3	1.6x10 <sup>3</sup>	4.4x10 <sup>4</sup>
Os-193		0.6	16.2	0.5	13.5	2.0x10 <sup>4</sup>	5.3x10 <sup>5</sup>
Os-194		0.2	5.41	0.2	5.41	1.1x10 <sup>1</sup>	3.1x10 <sup>2</sup>
P-32	Phosphorus(15)	0.3	8.11	0.3	8.11	1.1x10 <sup>4</sup>	2.9x10 <sup>5</sup>
P-33		40	1080	0.9	24.3	5.8x10 <sup>3</sup>	1.6x10 <sup>5</sup>
Pa-230	Protactinium(91)	2	54.1	0.1	2.70	1.2x10 <sup>3</sup>	3.3x10 <sup>4</sup>
Pa-231		0.6	16.2	6x10 <sup>-5</sup>	1.62x10 <sup>-3</sup>	1.7x10 <sup>-3</sup>	4.7x10 <sup>-2</sup>
Pa-233		5	135	0.9	24.3	7.7x10 <sup>2</sup>	2.1x10 <sup>4</sup>
Pb-201	Lead(82)	1	27.0	1	27.0	6.2x10 <sup>4</sup>	1.7x10 <sup>6</sup>
Pb-202		40	1080	2	54.1	1.2x10 <sup>-4</sup>	3.4x10 <sup>-3</sup>
Pb-203		3	81.1	3	81.1	1.1x10 <sup>4</sup>	3.0x10 <sup>5</sup>
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	4.5x10 <sup>-6</sup>	1.2x10 <sup>-4</sup>
Pb-210		0.6	16.2	9x10 <sup>-3</sup>	0.243	2.8	7.6x10 <sup>1</sup>
Pb-212		0.3	8.11	0.3	8.11	5.1x10 <sup>4</sup>	1.4x10 <sup>6</sup>
Pd-103	Palladium(46)	40	1080	40	1080	2.8x10 <sup>3</sup>	7.5x10 <sup>4</sup>
Pd-107		Unlimited	Unlimited	Unlimited	Unlimited	1.9x10 <sup>-5</sup>	5.1x10 <sup>-4</sup>

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
Pd-109	Promethium(61)	0.6	16.2	0.5	13.5	7.9x10 <sup>4</sup>	2.1x10 <sup>6</sup>
Pm-143		3	81.1	3	81.1	1.3x10 <sup>2</sup>	3.4x10 <sup>3</sup>
Pm-144		0.6	16.2	0.6	16.2	9.2x10 <sup>1</sup>	2.5x10 <sup>3</sup>
Pm-145		30	811	7	189	5.2	1.4x10 <sup>2</sup>
Pm-147		40	1080	0.9	24.3	3.4x10 <sup>1</sup>	9.3x10 <sup>2</sup>
Pm-148m		0.5	13.5	0.5	13.5	7.9x10 <sup>2</sup>	2.1x10 <sup>4</sup>
Pm-149		0.6	16.2	0.5	13.5	1.5x10 <sup>4</sup>	4.0x10 <sup>5</sup>
Pm-151	Polonium(84)	3	81.1	0.5	13.5	2.7x10 <sup>4</sup>	7.3x10 <sup>5</sup>
Po-208		40	1080	2x10 <sup>-2</sup>	0.541	2.2x10 <sup>1</sup>	5.9x10 <sup>2</sup>
Po-209		40	1080	2x10 <sup>-2</sup>	0.541	6.2x10 <sup>-1</sup>	1.7x10 <sup>1</sup>
Po-210	Praseodymium(59)	40	1080	2x10 <sup>-2</sup>	0.541	1.7x10 <sup>2</sup>	4.5x10 <sup>3</sup>
Pr-142		0.2	5.41	0.2	5.41	4.3x10 <sup>4</sup>	1.2x10 <sup>6</sup>
Pr-143		4	108	0.5	13.5	2.5x10 <sup>3</sup>	6.7x10 <sup>4</sup>
Pt-188	Platinum(78)	0.6	16.2	0.6	16.2	2.5x10 <sup>3</sup>	6.8x10 <sup>4</sup>
Pt-191		3	81.1	3	81.1	8.7x10 <sup>3</sup>	2.4x10 <sup>5</sup>
Pt-193m		40	1080	9	243	5.8x10 <sup>3</sup>	1.6x10 <sup>5</sup>
Pt-193	Plutonium(94)	40	1080	40	1080	1.4	3.7x10 <sup>1</sup>
Pt-195m		10	270	2	54.1	6.2x10 <sup>3</sup>	1.7x10 <sup>5</sup>
Pt-197m		10	270	0.9	24.3	3.7x10 <sup>5</sup>	1.0x10 <sup>7</sup>
Pt-197		20	541	0.5	13.5	3.2x10 <sup>4</sup>	8.7x10 <sup>5</sup>
Pu-236		7	189	7x10 <sup>-4</sup>	1.89x10 <sup>-2</sup>	2.0x10 <sup>1</sup>	5.3x10 <sup>2</sup>
Pu-237	20	541	20	541	4.5x10 <sup>2</sup>	1.2x10 <sup>4</sup>	
Pu-238	Plutonium(94)	2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	6.3x10 <sup>-1</sup>	1.7x10 <sup>1</sup>
Pu-239		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	2.3x10 <sup>-3</sup>	6.2x10 <sup>-2</sup>
Pu-240		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	8.4x10 <sup>-3</sup>	2.3x10 <sup>-1</sup>
Pu-241		40	1080	1x10 <sup>-2</sup>	0.270	3.8	1.0x10 <sup>2</sup>
Pu-242		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	1.5x10 <sup>-4</sup>	3.9x10 <sup>-3</sup>
Pu-244		0.3	8.11	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	6.7x10 <sup>-7</sup>	1.8x10 <sup>-5</sup>

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
Ra-223	Radium(88)	0.6	16.2	3x10 <sup>-2</sup>	0.811	1.9x10 <sup>3</sup>	5.1x10 <sup>4</sup>
Ra-224		0.3	8.11	6x10 <sup>-2</sup>	1.62	5.9x10 <sup>3</sup>	1.6x10 <sup>5</sup>
Ra-225		0.6	16.2	2x10 <sup>-2</sup>	0.541	1.5x10 <sup>3</sup>	3.9x10 <sup>4</sup>
Ra-226		0.3	8.11	2x10 <sup>-2</sup>	0.541	3.7x10 <sup>-2</sup>	1.0
Ra-228		0.6	16.2	4x10 <sup>-2</sup>	1.08	1.0x10 <sup>1</sup>	2.7x10 <sup>2</sup>
Rb-81		Rubidium(37)	2	54.1	0.9	24.3	3.1x10 <sup>5</sup>
Rb-83	2		54.1	2	54.1	6.8x10 <sup>2</sup>	1.8x10 <sup>4</sup>
Rb-84	1		27.0	0.9	24.3	1.8x10 <sup>3</sup>	4.7x10 <sup>4</sup>
Rb-86	0.3		8.11	0.3	8.11	3.0x10 <sup>3</sup>	8.1x10 <sup>4</sup>
Rb-87	Unlimited		Unlimited	Unlimited	Unlimited	3.2x10 <sup>-9</sup>	8.6x10 <sup>-8</sup>
Rb (natural)	Unlimited		Unlimited	Unlimited	Unlimited	6.7x10 <sup>6</sup>	1.8x10 <sup>8</sup>
Re-183	Rhenium(75)	5	135	5	135	3.8x10 <sup>2</sup>	1.0x10 <sup>4</sup>
Re-184m		3	81.1	3	81.1	1.6x10 <sup>2</sup>	4.3x10 <sup>3</sup>
Re-184		1	27.0	1	27.0	6.9x10 <sup>2</sup>	1.9x10 <sup>4</sup>
Re-186		4	108	0.5	13.5	6.9x10 <sup>3</sup>	1.9x10 <sup>5</sup>
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	1.4x10 <sup>-9</sup>	3.8x10 <sup>-8</sup>
Re-188		0.2	5.41	0.2	5.41	3.6x10 <sup>4</sup>	9.8x10 <sup>5</sup>
Re-189		4	108	0.5	13.5	2.5x10 <sup>4</sup>	6.8x10 <sup>5</sup>
Re (natural)		Unlimited	Unlimited	Unlimited	Unlimited	—	2.4x10 <sup>-8</sup>
Rh-99		Rhodium(45)	2	54.1	2	54.1	3.0x10 <sup>3</sup>
Rh-101	4		108	4	108	4.1x10 <sup>1</sup>	1.1x10 <sup>3</sup>
Rh-102m	2		54.1	0.9	24.3	2.3x10 <sup>2</sup>	6.2x10 <sup>3</sup>
Rh-102	0.5		13.5	0.5	13.5	4.5x10 <sup>1</sup>	1.2x10 <sup>3</sup>
Rh-103m	40		1080	40	1080	1.2x10 <sup>6</sup>	3.3x10 <sup>7</sup>
Rh-105	10		270	0.9	24.3	3.1x10 <sup>4</sup>	8.4x10 <sup>5</sup>
Rn-222	Radon(86)	0.2	5.41	4x10 <sup>-3</sup>	0.108	5.7x10 <sup>3</sup>	1.5x10 <sup>5</sup>
Ru-97	Ruthenium(44)	4	108	4	108	1.7x10 <sup>4</sup>	4.6x10 <sup>5</sup>
Ru-103		2	54.1	0.9	24.3	1.2x10 <sup>3</sup>	3.2x10 <sup>4</sup>

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub>		A <sub>2</sub>		Specific Activity	
		(TBq)	(Ci)	(TBq)	(Ci)	(TBq/g)	(Ci/g)
Ru-105		0.6	16.2	0.5	13.5	2.5x10 <sup>5</sup>	6.7x10 <sup>6</sup>
Ru-106		0.2	5.41	0.2	5.41	1.2x10 <sup>2</sup>	3.3x10 <sup>3</sup>
S-35	Sulfur(16)	40	1080	2	54.1	1.6x10 <sup>3</sup>	4.3x10 <sup>4</sup>
Sb-122	Antimony(51)	0.3	8.11	0.3	8.11	1.5x10 <sup>4</sup>	4.0x10 <sup>5</sup>
Sb-124		0.6	16.2	0.5	13.5	6.5x10 <sup>2</sup>	1.7x10 <sup>4</sup>
Sb-125		2	54.1	0.9	24.3	3.9x10 <sup>1</sup>	1.0x10 <sup>3</sup>
Sb-126		0.4	10.8	0.4	10.8	3.1x10 <sup>3</sup>	8.4x10 <sup>4</sup>
Sc-44	Scandium(21)	0.5	13.5	0.5	13.5	6.7x10 <sup>5</sup>	1.8x10 <sup>7</sup>
Sc-46		0.5	13.5	0.5	13.5	1.3x10 <sup>3</sup>	3.4x10 <sup>4</sup>
Sc-47		9	243	0.9	24.3	3.1x10 <sup>4</sup>	8.3x10 <sup>5</sup>
Sc-48		0.3	8.11	0.3	8.11	5.5x10 <sup>4</sup>	1.5x10 <sup>6</sup>
Se-75	Selenium(34)	3	81.1	3	81.1	5.4x10 <sup>2</sup>	1.5x10 <sup>4</sup>
Se-79		40	1080	2	54.1	2.6x10 <sup>-3</sup>	7.0x10 <sup>-2</sup>
Si-31	Silicon(14)	0.6	16.2	0.5	13.5	1.4x10 <sup>6</sup>	3.9x10 <sup>7</sup>
Si-32		40	1080	0.2	5.41	3.9	1.1x10 <sup>2</sup>
Sm-145	Samarium(62)	20	541	20	541	9.8x10 <sup>1</sup>	2.6x10 <sup>3</sup>
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	8.5x10 <sup>-1</sup>	2.3x10 <sup>-8</sup>
Sm-151		40	1080	4	108	9.7x10 <sup>-1</sup>	2.6x10 <sup>1</sup>
Sm-153		4	108	0.5	13.5	1.6x10 <sup>4</sup>	4.4x10 <sup>5</sup>
Sn-113	Tin(50)	4	108	4	108	3.7x10 <sup>2</sup>	1.0x10 <sup>4</sup>
Sn-117m		6	162	2	54.1	3.0x10 <sup>3</sup>	8.2x10 <sup>4</sup>
Sn-119m		40	1080	40	1080	1.4x10 <sup>2</sup>	3.7x10 <sup>3</sup>
Sn-121m		40	1080	0.9	24.3	2.0	5.4x10 <sup>1</sup>
Sn-123		0.6	16.2	0.5	13.5	3.0x10 <sup>2</sup>	8.2x10 <sup>3</sup>
Sn-125		0.2	5.41	0.2	5.41	4.0x10 <sup>3</sup>	1.1x10 <sup>5</sup>
Sn-126		0.3	8.11	0.3	8.11	1.0x10 <sup>-3</sup>	2.8x10 <sup>-2</sup>
Sr-82	Strontium(38)	0.2	5.41	0.2	5.41	2.3x10 <sup>3</sup>	6.2x10 <sup>4</sup>
Sr-85m		5	135	5	135	1.2x10 <sup>6</sup>	3.3x10 <sup>7</sup>

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>2</sub>	Specific Activity	
		(TBq)	(Ci)	(TBq)	(Ci)	(TBq/g)	(Ci/g)
Sr-85		2	54.1	2	54.1	8.8x10 <sup>2</sup>	2.4x10 <sup>4</sup>
Sr-87m		3	81.1	3	81.1	4.8x10 <sup>5</sup>	1.3x10 <sup>7</sup>
Sr-89		0.6	16.2	0.5	13.5	1.1x10 <sup>3</sup>	2.9x10 <sup>4</sup>
Sr-90		0.2	5.41	0.1	2.70	5.1	1.4x10 <sup>2</sup>
Sr-91		0.3	8.11	0.3	8.11	1.3x10 <sup>5</sup>	3.6x10 <sup>6</sup>
Sr-92		0.8	21.6	0.5	13.5	4.7x10 <sup>5</sup>	1.3x10 <sup>7</sup>
T	Tritium(1)	40	1080	40	1080	3.6x10 <sup>2</sup>	9.7x10 <sup>3</sup>
Ta-178	Tantalum(73)	1	27.0	1	27.0	4.2x10 <sup>6</sup>	1.1x10 <sup>8</sup>
Ta-179		30	811	30	811	4.1x10 <sup>1</sup>	1.1x10 <sup>3</sup>
Ta-182		0.8	21.6	0.5	13.5	2.3x10 <sup>2</sup>	6.2x10 <sup>3</sup>
Tb-157	Terbium(65)	40	1080	10	270	5.6x10 <sup>-1</sup>	1.5x10 <sup>1</sup>
Tb-158		1	27.0	0.7	18.9	5.6x10 <sup>-1</sup>	1.5x10 <sup>1</sup>
Tb-160		0.9	24.3	0.5	13.5	4.2x10 <sup>2</sup>	1.1x10 <sup>4</sup>
Tc-95m	Technetium(43)	2	54.1	2	54.1	8.3x10 <sup>2</sup>	2.2x10 <sup>4</sup>
Tc-96m		0.4	10.8	0.4	10.8	1.4x10 <sup>6</sup>	3.8x10 <sup>7</sup>
Tc-96		0.4	10.8	0.4	10.8	1.2x10 <sup>4</sup>	3.2x10 <sup>5</sup>
Tc-97m		40	1080	40	1080	5.6x10 <sup>2</sup>	1.5x10 <sup>4</sup>
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	5.2x10 <sup>-5</sup>	1.4x10 <sup>-3</sup>
Tc-98		0.7	18.9	0.7	18.9	3.2x10 <sup>-5</sup>	8.7x10 <sup>-4</sup>
Tc-99m		8	216	8	216	1.9x10 <sup>5</sup>	5.3x10 <sup>6</sup>
Tc-99		40	1080	0.9	24.3	6.3x10 <sup>-4</sup>	1.7x10 <sup>-2</sup>
Te-118	Tellurium(52)	0.2	5.41	0.2	5.41	6.8x10 <sup>3</sup>	1.8x10 <sup>5</sup>
Te-121m		5	135	5	135	2.6x10 <sup>2</sup>	7.0x10 <sup>3</sup>
Te-121		2	54.1	2	54.1	2.4x10 <sup>3</sup>	6.4x10 <sup>4</sup>
Te-123m		7	189	7	189	3.3x10 <sup>2</sup>	8.9x10 <sup>3</sup>
Te-125m		30	811	9	243	6.7x10 <sup>2</sup>	1.8x10 <sup>4</sup>

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
Te-127m		20	541	0.5	13.5	3.5x10 <sup>2</sup>	9.4x10 <sup>3</sup>
Te-127		20	541	0.5	13.5	9.8x10 <sup>4</sup>	2.6x10 <sup>6</sup>
Te-129m		0.6	16.2	0.5	13.5	1.1x10 <sup>3</sup>	3.0x10 <sup>4</sup>
Te-129		0.6	16.2	0.5	13.5	7.7x10 <sup>5</sup>	2.1x10 <sup>7</sup>
Te-131m		0.7	18.9	0.5	13.5	3.0x10 <sup>4</sup>	8.0x10 <sup>5</sup>
Te-132		0.4	10.8	0.4	10.8	1.1x10 <sup>4</sup>	3.0x10 <sup>5</sup>
Th-227	Thorium(90)	9	243	1x10 <sup>-2</sup>	0.270	1.1x10 <sup>3</sup>	3.1x10 <sup>4</sup>
Th-228		0.3	8.11	4x10 <sup>-4</sup>	1.08x10 <sup>-2</sup>	3.0x10 <sup>1</sup>	8.2x10 <sup>2</sup>
Th-229		0.3	8.11	3x10 <sup>-5</sup>	8.11x10 <sup>-4</sup>	7.9x10 <sup>-3</sup>	2.1x10 <sup>-1</sup>
Th-230		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	7.6x10 <sup>-4</sup>	2.1x10 <sup>-2</sup>
Th-231		40	1080	0.9	24.3	2.0x10 <sup>4</sup>	5.3x10 <sup>5</sup>
Th-232		Unlimited	Unlimited	Unlimited	Unlimited	4.0x10 <sup>-9</sup>	1.1x10 <sup>-7</sup>
Th-234		0.2	5.41	0.2	5.41	8.6x10 <sup>2</sup>	2.3x10 <sup>4</sup>
Th (natural)		Unlimited	Unlimited	Unlimited	Unlimited	8.1x10 <sup>-9</sup>	2.2x10 <sup>-7</sup>
Ti-144	Titanium(22)	0.5	13.5	0.2	5.41	6.4	1.7x10 <sup>2</sup>
Tl-200	Thallium(81.1)	0.8	21.6	0.8	21.6	2.2x10 <sup>4</sup>	6.0x10 <sup>5</sup>
Tl-201		10	270	10	270	7.9x10 <sup>3</sup>	2.1x10 <sup>5</sup>
Tl-202		2	54.1	2	54.1	2.0x10 <sup>3</sup>	5.3x10 <sup>4</sup>
Tl-204		4	108	0.5	13.5	1.7x10 <sup>1</sup>	4.6x10 <sup>2</sup>
Tm-167	Thulium(69)	7	189	7	189	3.1x10 <sup>3</sup>	8.5x10 <sup>4</sup>
Tm-168		0.8	21.6	0.8	21.6	3.1x10 <sup>2</sup>	8.3x10 <sup>3</sup>
Tm-170		4	108	0.5	13.5	2.2x10 <sup>2</sup>	6.0x10 <sup>3</sup>
Tm-171		40	1080	10	270	4.0x10 <sup>1</sup>	1.1x10 <sup>3</sup>
U-230	Uranium(92)	40	1080	1x10 <sup>-2</sup>	0.270	1.0x10 <sup>3</sup>	2.7x10 <sup>4</sup>
U-232		3	81.1	3x10 <sup>-4</sup>	8.11x10 <sup>-3</sup>	8.3x10 <sup>-1</sup>	2.2x10 <sup>1</sup>
U-233		10	270	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	3.6x10 <sup>-4</sup>	9.7x10 <sup>-3</sup>
U-234		10	270	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	2.3x10 <sup>-4</sup>	6.2x10 <sup>-3</sup>

A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
U-235		Unlimited	Unlimited	Unlimited	Unlimited	8.0x10 <sup>-8</sup>	2.2x10 <sup>-6</sup>
U-236		10	270	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	2.4x10 <sup>-6</sup>	6.5x10 <sup>-5</sup>
U-238		Unlimited	Unlimited	Unlimited	Unlimited	1.2x10 <sup>-8</sup>	3.4x10 <sup>-7</sup>
U (natural)		Unlimited	Unlimited	Unlimited	Unlimited	2.6x10 <sup>-8</sup>	7.1x10 <sup>-7</sup>
U (enriched 5% or less)		Unlimited	Unlimited	Unlimited	Unlimited	—	*
U (enriched more than 5%)		10	270	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	—	*
U (depleted)		Unlimited	Unlimited	Unlimited	Unlimited	—	*
V-48	Vanadium(23)	0.3	8.11	0.3	8.11	6.3x10 <sup>3</sup>	1.7x10 <sup>5</sup>
V-49		40	1080	40	1080	3.0x10 <sup>2</sup>	8.1x10 <sup>3</sup>
W-178	Tungsten(74)	1	27.0	1	27.0	1.3x10 <sup>3</sup>	3.4x10 <sup>4</sup>
W-181		30	811	30	811	2.2x10 <sup>2</sup>	6.0x10 <sup>3</sup>
W-185		40	1080	0.9	24.3	3.5x10 <sup>2</sup>	9.4x10 <sup>3</sup>
W-187		2	54.1	0.5	13.5	2.6x10 <sup>4</sup>	7.0x10 <sup>5</sup>
W-188		0.2	5.41	0.2	5.41	3.7x10 <sup>2</sup>	1.0x10 <sup>4</sup>
Xe-122	Xenon(54)	0.2	5.41	0.2	5.41	4.8x10 <sup>4</sup>	1.3x10 <sup>6</sup>
Xe-123		0.2	5.41	0.2	5.41	4.4x10 <sup>5</sup>	1.2x10 <sup>7</sup>
Xe-127		4	108	4	108	1.0x10 <sup>3</sup>	2.8x10 <sup>4</sup>
Xe-131m		40	1080	40	1080	3.1x10 <sup>3</sup>	8.4x10 <sup>4</sup>
Xe-133		20	541	20	541	6.9x10 <sup>3</sup>	1.9x10 <sup>5</sup>
Xe-135		4	108	4	108	9.5x10 <sup>4</sup>	2.6x10 <sup>6</sup>
Y-87	Yttrium(39)	2	54.1	2	54.1	1.7x10 <sup>4</sup>	4.5x10 <sup>5</sup>
Y-88		0.4	10.8	0.4	10.8	5.2x10 <sup>2</sup>	1.4x10 <sup>4</sup>
Y-90		0.2	5.41	0.2	5.41	2.0x10 <sup>4</sup>	5.4x10 <sup>5</sup>
Y-91m		2	54.1	2	54.1	1.5x10 <sup>6</sup>	4.2x10 <sup>7</sup>
Y-91		0.3	8.11	0.3	8.11	9.1x10 <sup>2</sup>	2.5x10 <sup>4</sup>
Y-92		0.2	5.41	0.2	5.41	3.6x10 <sup>5</sup>	9.6x10 <sup>6</sup>

\* See subsection (s)(4) of this section.



A<sub>1</sub> and A<sub>2</sub> Values for Radionuclides (Cont.)

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity	
						(TBq/g)	(Ci/g)
Y-93		0.2	5.41	0.2	5.41	1.2x10 <sup>5</sup>	3.3x10 <sup>6</sup>
Yb-169	Ytterbium(70)	3	81.1	3	81.1	8.9x10 <sup>2</sup>	2.4x10 <sup>4</sup>
Yb-175		30	811	0.9	24.3	6.6x10 <sup>3</sup>	1.8x10 <sup>5</sup>
Zn-65	Zinc(30)	2	54.1	2	54.1	3.0x10 <sup>2</sup>	8.2x10 <sup>3</sup>
Zn-69m		2	54.1	0.5	13.5	1.2x10 <sup>5</sup>	3.3x10 <sup>6</sup>
Zn-69		4	108	0.5	13.5	1.8x10 <sup>6</sup>	4.9x10 <sup>7</sup>
Zr-88	Zirconium(40)	3	81.1	3	81.1	6.6x10 <sup>2</sup>	1.8x10 <sup>4</sup>
Zr-93		40	1080	0.2	5.41	9.3x10 <sup>-5</sup>	2.5x10 <sup>-3</sup>
Zr-95		1	27.0	0.9	24.3	7.9x10 <sup>2</sup>	2.1x10 <sup>4</sup>
Zr-97		0.3	8.11	0.3	8.11	7.1x10 <sup>4</sup>	1.9x10 <sup>6</sup>

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(3) General values for  $A_1$  and  $A_2$ . The following table contains general values for  $A_1$  and  $A_2$ :

Contents	$A_1$		$A_2$	
	(TBq)	(Ci)	(TBq)	(Ci)
Only beta- or gamma-emitting nuclides are known to be present.	0.2	5	0.02	0.5
Alpha-emitting nuclides are known to be present, or no relevant data are available.	0.10	2.70	$2 \times 10^{-5}$	$5.41 \times 10^{-4}$

(4) Activity-mass relationships for uranium. The following table contains activity-mass relationships for uranium:

Uranium Enrichment* wt % U-235 present	Specific Activity	
	TBq/g	Ci/g
0.45	$1.8 \times 10^{-8}$	$5.0 \times 10^{-7}$
0.72	$2.6 \times 10^{-8}$	$7.1 \times 10^{-7}$
1.0	$2.8 \times 10^{-8}$	$7.6 \times 10^{-7}$
1.5	$3.7 \times 10^{-8}$	$1.0 \times 10^{-6}$
5.0	$1.0 \times 10^{-7}$	$2.7 \times 10^{-6}$
10.0	$1.8 \times 10^{-7}$	$4.8 \times 10^{-6}$
20.0	$3.7 \times 10^{-7}$	$1.0 \times 10^{-5}$
35.0	$7.4 \times 10^{-7}$	$2.0 \times 10^{-5}$
50.0	$9.3 \times 10^{-7}$	$2.5 \times 10^{-5}$
90.0	$2.2 \times 10^{-6}$	$5.8 \times 10^{-5}$
93.0	$2.6 \times 10^{-6}$	$7.0 \times 10^{-5}$
95.0	$3.4 \times 10^{-6}$	$9.1 \times 10^{-5}$

\* The figures for uranium include representative values for the activity of the uranium-235 which is concentrated during the enrichment process.

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(5) Requirements for transfers of LLRW intended for disposal at licensed land disposal facilities and manifests.

(A) Manifest. A waste generator, collector, or processor who transports, or offers for transportation, LLRW intended for ultimate disposal at a licensed LLRW land disposal facility must prepare a manifest reflecting information requested on applicable BRC Forms 540 (Uniform Low-Level Radioactive Waste Manifest (Shipping Paper)) and 541 (Uniform Low-Level Radioactive Waste Manifest (Container and Waste Description)) and, if necessary, on an applicable BRC Form 542 (Uniform Low-Level Radioactive Waste Manifest (Manifest Index and Regional Compact Tabulation)) or their equivalent. BRC Forms 540 and 540A must be completed and must physically accompany the pertinent LLRW shipment. Upon agreement between shipper and consignee, BRC Forms 541, 541A and 541B, and 542 and 542A may be completed, transmitted, and stored in electronic media with the capability for producing legible, accurate, and complete records on the respective forms. Licensees are not required by the agency to comply with the manifesting requirements of this section when they ship:

(i) LLRW for processing and expect its return (i.e., for storage under their license) prior to disposal at a licensed land disposal facility;

(ii) LLRW that is being returned to the licensee who is the waste generator or generator, as defined in this section; or

(iii) radioactively contaminated material to a waste processor that becomes the processor's residual waste.

(B) Form instructions. For guidance in completing these forms, refer to the instructions that accompany the forms. Copies of manifests required by this subsection may be legible carbon copies, photocopies, or computer printouts that reproduce the data in the format of the uniform manifest.

(C) Forms. BRC Forms 540, 540A, 541, 541A, 541B, 542 and 542A, and the accompanying instructions, in hard copy, may be obtained from the agency.

(D) Information requirements of the DOT. This subsection includes information requirements of the DOT, as codified in 49 CFR Part 172. Information on hazardous, medical, or other waste, required to meet EPA regulations, as codified in 40 CFR Parts 259, 261 or elsewhere, is not addressed in this section, and must be provided on the required EPA forms. However, the required EPA forms must accompany the uniform manifest required by this section.

(E) General information. The shipper of the LLRW, shall provide the following information on the uniform manifest:

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(i) the name, facility address, and telephone number of the licensee shipping the waste;

(ii) an explicit declaration indicating whether the shipper is acting as a waste generator, collector, processor, or a combination of these identifiers for purposes of the manifested shipment; and

(iii) the name, address, and telephone number, or the name and EPA identification number for the carrier transporting the waste.

(F) Shipment information. The shipper of the LLRW shall provide the following information regarding the waste shipment on the uniform manifest:

(i) the date of the waste shipment;

(ii) the total number of packages/disposal containers;

(iii) the total disposal volume and disposal weight in the shipment;

(iv) the total radionuclide activity in the shipment;

(v) the activity of each of the radionuclides hydrogen-3, carbon-14, technetium-99, iodine-129, chlorine-36, nickel-63, strontium-90, cesium-137, radium-226, and any other isotopes with a half-life greater than 35 years contained in the shipment; and

(vi) the total masses of uranium-233, uranium-235, and plutonium in special nuclear material, and the total mass of uranium and thorium in source material.

(G) Disposal container and waste information. The shipper of the LLRW shall provide the following information on the uniform manifest regarding the waste and each disposal container of waste in the shipment:

(i) an alphabetic or numeric identification that uniquely identifies each disposal container in the shipment;

(ii) a physical description of the disposal container, including the manufacturer and model of any high integrity container;

(iii) the volume displaced by the disposal container;

(iv) the gross weight of the disposal container, including the waste;

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(v) for waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container;

(vi) a physical and chemical description of the waste;

(vii) the total weight percentage of chelating agent for any waste containing more than 0.1 % chelating agent by weight, plus the identity of the principal chelating agent;

(viii) the approximate volume of waste within a container;

(ix) the sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name;

(x) the identities and activities of individual radionuclides contained in each container, the masses of uranium-233, uranium-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material. For discrete waste types (i.e., activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides associated with or contained on these waste types within a disposal container shall be reported;

(xi) the total radioactivity within each container; and

(xii) for wastes consigned to a disposal facility, the classification of the waste in accordance with §289.202(ggg)(4)(A) of this title. Waste not meeting the structural stability requirements of §289.202(ggg)(4)(B)(ii) of this title must be identified.

(H) Uncontainerized waste information. The shipper of the LLRW shall provide the following information on the uniform manifest regarding a waste shipment delivered without a disposal container:

(i) the approximate volume and weight of the waste;

(ii) a physical and chemical description of the waste;

(iii) the total weight percentage of chelating agent if the chelating agent exceeds 0.1 % by weight, plus the identity of the principal chelating agent;

(iv) for waste consigned to a disposal facility, the classification of the waste in accordance with §289.202(ggg)(4)(A) of this title. Waste not meeting the structural stability requirements of §289.202(ggg)(4)(B)(ii) of this title must be identified;

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(v) the identities and activities of individual radionuclides contained in the waste, the masses of uranium-233, uranium-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material; and

(vi) for wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

(I) Multi-generator disposal container information. This subparagraph applies to disposal containers enclosing mixtures of waste originating from different generators. (Note: The origin of the LLRW resulting from a processor's activities may be attributable to one or more generators (including waste generators) as defined in this section). It also applies to mixtures of wastes shipped in an uncontainerized form, for which portions of the mixture within the shipment originate from different generators.

(i) For homogeneous mixtures of waste, such as incinerator ash, provide the waste description applicable to the mixture and the volume of the waste attributed to each generator.

(ii) For heterogeneous mixtures of waste, such as the combined products from a large compactor, identify each generator contributing waste to the disposal container, and, for discrete waste types (i.e., activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides contained on these waste types within the disposal container. For each generator, provide the following:

(I) the volume of waste within the disposal container;

(II) a physical and chemical description of the waste, including the solidification agent, if any;

(III) the total weight percentage of chelating agents for any disposal container containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;

(IV) the sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name if the media is claimed to meet stability requirements in §289.202(ggg)(4)(B)(ii) of this title; and

(V) radionuclide identities and activities contained in the waste, the masses of uranium-233, uranium-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material if contained in the waste.

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(J) Certification. An authorized representative of the waste generator, processor, or collector shall certify by signing and dating the shipment manifest that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the DOT and the agency. A collector in signing the certification is certifying that nothing has been done to the collected waste which would invalidate the waste generator's certification.

(K) Control and tracking.

(i) Any licensee who transfers LLRW to a land disposal facility or a licensed waste collector shall comply with the requirements in subclauses (I)-(IX) of this clause. Any licensee who transfers waste to a licensed waste processor for waste treatment or repackaging shall comply with the requirements of subclauses (IV)-(IX) of this clause. A licensee shall:

(I) prepare all wastes so that the waste is classified according to §289.202(ggg)(4)(A) of this title and meets the waste characteristic requirements in §289.202(ggg)(4)(B) of this title;

(II) label each disposal container (or transport package if potential radiation hazards preclude labeling of the individual disposal container) of waste to identify whether it is Class A waste, Class B waste, Class C waste, or greater than Class C waste, in accordance with §289.202(ggg)(4)(A) of this title;

(III) conduct a quality assurance program to assure compliance with §289.202(ggg)(4)(A) and (B) of this title;

(IV) prepare the uniform manifest as required by this subsection;

(V) forward a copy or electronically transfer the uniform manifest to the intended consignee so that either:

(-a-) receipt of the manifest precedes the LLRW shipment; or

(-b-) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both items (-a-) and (-b-) of this subclause is also acceptable;

(VI) include the uniform manifest with the shipment regardless of the option chosen in subclause (V) of this clause;

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(VII) receive acknowledgement of the receipt of the shipment in the form of a signed copy of the uniform manifest;

(VIII) retain a copy of or electronically store the uniform manifest and documentation of acknowledgement of receipt as the record of transfer of radioactive material as required by §289.251 of this title, §289.252 of this title, and §289.254 of this title; and

(IX) for any shipments or any part of a shipment for which acknowledgement of receipt has not been received within the times set forth in this subsection, conduct an investigation in accordance with clause (v) of this subparagraph.

(ii) Any waste collector licensee who handles only prepackaged waste shall:

(I) acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of the uniform manifest;

(II) prepare a new uniform manifest to reflect consolidated shipments that meet the requirements of this subsection. The waste collector shall ensure that, for each container of waste in the shipment, the uniform manifest identifies the generator of that container of waste;

(III) forward a copy or electronically transfer the uniform manifest to the intended consignee so that either:

(-a-) receipt of the uniform manifest precedes the LLRW shipment; or

(-b-) the uniform manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both items (-a-) and (-b-) of this subclause is also acceptable;

(IV) include the uniform manifest with the shipment regardless of the option chosen in subclause (III) of this clause;

(V) receive acknowledgement of the receipt of the shipment in the form of a signed copy of the uniform manifest;

(VI) retain a copy of or electronically store the uniform manifest and documentation of acknowledgement of receipt as the record of transfer of radioactive material as required by §289.251 of this title, §289.252 of this title, and §289.254 of this title;



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(VII) for any shipments or any part of a shipment for which acknowledgement of receipt has not been received within the times set forth in this clause, conduct an investigation in accordance with clause (v) of this subparagraph; and

(VIII) notify the shipper and the agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance uniform manifest, unless notified by the shipper that the shipment has been cancelled.

(iii) Any licensed waste processor who treats or repackages waste shall:

(I) acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of the uniform manifest;

(II) prepare a new uniform manifest that meets the requirements of this subsection. Preparation of the new uniform manifest reflects that the processor is responsible for meeting these requirements. For each container of waste in the shipment, the manifest shall identify the waste generators, the preprocessed waste volume, and the other information as required in subparagraph (I) of this paragraph;

(III) prepare all wastes so that the waste is classified according to §289.202(ggg)(4)(A) of this title and meets the waste characteristics requirements in §289.202(ggg)(4)(B) of this title;

(IV) label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with §289.202(ggg)(4)(A) and (C) of this title;

(V) conduct a quality assurance program to assure compliance with §289.202(ggg)(4)(A) and (B) of this title;

(VI) forward a copy or electronically transfer the uniform manifest to the intended consignee so that either:

(-a-) receipt of the uniform manifest precedes the LLRW shipment; or

(-b-) the uniform manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both items (-a-) and (-b-) of this subclause is also acceptable;

(VII) include the uniform manifest with the shipment regardless of the option chosen in subclause (VI) of this clause;

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(VIII) receive acknowledgement of the receipt of the shipment in the form of a signed copy of the uniform manifest;

(IX) retain a copy of or electronically store the uniform manifest and documentation of acknowledgement of receipt as the record of transfer of radioactive material as required by §289.251 of this title, §289.252 of this title, and §289.254 of this title;

(X) for any shipment or any part of a shipment for which acknowledgement of receipt has not been received within the times set forth in this clause, conduct an investigation in accordance with clause (v) of this subparagraph; and

(XI) notify the shipper and the agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance uniform manifest, unless notified by the shipper that the shipment has been cancelled.

(iv) The land disposal facility operator shall perform the following:

(I) acknowledge receipt of the waste within one week of receipt by returning, as a minimum, a signed copy of the uniform manifest to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. If any discrepancy exists between materials listed on the uniform manifest and materials received, copies or electronic transfer of the affected forms must be returned indicating the discrepancy;

(II) maintain copies of all completed uniform manifests and electronically store the information required by §289.202(ggg)(4)(C)(iv)(II) of this title until the agency terminates the license; and

(III) notify the shipper and the agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance uniform manifest, unless notified by the shipper that the shipment has been cancelled.

(v) Any shipment or part of a shipment for which acknowledgement is not received within the times set forth in this section must undergo the following:

(I) be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and

(II) be traced and reported. The investigation shall include tracing the shipment and filing a report with the agency. Each licensee who conducts a trace investigation shall file a written report with the agency within two weeks of completion of the investigation.